BRIDGING THE GAP:
Transforming Knowledge into Action through Gaming and Simulation

Proceedings of the 35th Conference of the International Simulation and Gaming Association, Munich, 2004

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Design and Layout: Adrian Döge

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ISBN: 3-00-013989-3

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Theory-oriented evaluation of gaming simulations - The case of Simgame

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1. Introduction

Today, we look back on a long-lasting history of gaming simulations and their usage for educational purposes. The history of efforts to study and prove their effectiveness and efficiency as a learning tool is nearly just as long (Wolfe & Crookall, 1998). Yet, up to now, no consistent procedure for evaluating gaming simulations has taken shape, and no well-defined measures for learning outcomes have been established (Feinstein & Cannon, 2002). Accordingly, a frequent critique in the gaming simulation literature concerns the conduct and results of evaluation activities. Too often, it is argued, evaluations are based on anecdotal evidence (Greenblat, 1989), lack methodological rigor (Remus, 1981; Dorn, 1989), fail to use valid outcome criteria (Wolfe, 1990; Anderson & Lawton, 1992; Feinstein & Cannon, 2002), or apply unsatisfactory measurement techniques (Spector, 2000; Spector, Christensen, Sioutine & McCormack, 2001).

Even when we confine the picture to research that is considered to be methodologically sound, deficits of traditional evaluation activities become evident. This can be exemplified by a review of 25 years of research on business simulation games, as conducted by Faria (2001). Although the overall picture suggests that gaming simulation is an effective and efficient learning tool, the results of the relevant studies are far from being ambiguous and contradictory. Such heterogeneous results are a strong indicator that mediating factors exist which exhibit an important influence in making learning effective. For practitioners, such as designers and trainers of simulations, it would be of considerable value to learn more about these influences. However, since most studies concentrate on showing if simulations are effective, e.g. in comparison to the case method (Wolfe, 1997), they fall short of enlightening the specific conditions and factors that must be met to make simulations an efficient learning tool. So the problem is that knowing if an educational method such as gaming simulation works is only relevant if we also know why and how it works. Therefore, one can diagnose that despite considerable efforts have been spent in the evaluation of gaming simulation over the recent years, too little attention has been paid to generating knowledge about mechanisms underlying effective learning with gaming simulations.

This diagnosis has a striking parallel in the history of general evaluation theory development (cf. Rossi, Lipsey & Freeman, 2004; Shadish, Cook & Leviton, 1991). Here, too, we can observe a growing awareness over the last three decades that mere outcome-focused studies are only of limited value.
for everyday practice. As Cronbach and his colleagues put it: “Everybody seems to think that evaluation is not rendering the service it should” (Cronbach et al., 1980, p. 44). One of the most important developments in the field of general program evaluation [1], that took place in reaction to these concerns, was the emergence of theory-oriented evaluation approaches. These approaches have in common that they emphasize the use of logic models (“theories”) in studying and explaining how a program or a learning method produces desired and unintentional outcomes.

Therefore, in the following sections of this paper it is our aim to introduce the theory-oriented approach to evaluation. We will discuss its possible merits in regard to evaluation of gaming simulations and how it can help to ameliorate the problems of more traditional evaluation approaches discussed above. Finally, we will demonstrate the implementation of theory-oriented evaluation by outlining the evaluation concept of Simgame, a gaming simulation for business education. Since Simgame (Weinert & Puschert, this volume) and results of the first evaluation cycle (Kriz & Hense, this volume) are presented in other papers, this paper concentrates on questions related to evaluation theory and the evaluation concept of Simgame.

2. Theory-driven evaluation approaches

When talking about theory-oriented approaches to evaluation, it is important to make two clarifications to prevent misunderstandings. The first one is terminological, since up to now, different labels for such approaches are in use. Among them are theory-driven evaluation (Chen & Rossi, 1983; Chen, 1990), theory-based evaluation (Weiss, 1997), program theory evaluation (Rogers, Petrosino, Huebner & Hacsi, 2000), and theory-oriented evaluation (Stame, 2004). Since we consider it to be the least misleading one, we will use “theory-oriented evaluation” in the context of this paper, although often the different labels are used interchangeably in literature.

A second clarification has to be made concerning the term “theory”. Here, it does not refer to a theory of evaluation, but to the theoretical assumptions underlying the program evaluated and/or its evaluation design. Terms that usually are used interchangeably with ‘program theory’ are ‘theory of change’, ‘program model’, or ‘logic model’. Since the term “theory” is easily misunderstood, and tends to appear a bit too strong in practical contexts, we prefer the terms ‘program model’ or ‘logic model’.

The central thesis in theory-oriented approaches is that evaluations should be based on a logic model which explains how the interaction of a program, its participants, and its environment is expected to elicit the program’s desired (and unintentional) outcomes. So in the case of gaming simulations as learning tools, a logic model would have to be based on theoretical assumptions and empirical evidence derived from learning psychology, education, and simulation gaming theory, and should depict how simulation features, learner characteristics, and context conditions interact in generating learning outcomes.
Logic models typically consist of several variables, that are relevant in the context of the evaluated program, and descriptions of their mutual relationships. Since these relationships describe assumed causal relationships among the variables, normally at least antecedent variables (“input”), variables related to program activities (“process”), and variables related to program effects (“outcome”) are contained in a logic model. Often, logic models are represented graphically with boxes and arrows representing variables and their mutual causal relationships.

### 2.1. Origins of theory driven approaches

The origins of theory-oriented evaluation can be traced back as far as to the seminal writings of evaluation theorists such as Suchman (1967) or Weiss (1972). They emphasized that when planning and conducting evaluations, it is not sufficient to confine the study to observing input and output variables. Additionally, evaluators should explicitly refer to conceptualizations of intended processes of the program and mediating factors. Weiss (1972) is usually credited for proposing the use of “program models” to describe intended processes and outcomes of programs. It is probably the earliest reference to what we call program theory today.

The first authors to explicitly use the term “theory-based evaluation” are Fitz-Gibbon and Morris (1975): “A theory-based evaluation of a program is one in which the selection of program features to evaluate is determined by an explicit conceptualization of the program in terms of a theory, a theory which attempts to explain how the program produces the desired effects” (p. 1). This quotation makes clear that Fitz-Gibbon and Morris saw the main use of program theory in identifying relevant variables in designing evaluations. Their approach was a reaction to a feeling that, up to then, the choice of variables often had been a matter of evaluators’ subjective opinions instead of theoretical considerations. Later, theory-oriented approaches extended possible uses of program theory in evaluation (Bickman, 1987; see below).

So although the concepts of theory-oriented approaches have been around for quite a while, they became popular on a broader basis since the 1990s. One main motivation behind this rising popularity was criticism of so-called ‘black-box evaluations’ (Chen & Rossi, 1983; Chen, 1990). “The black box is the space between the actual input and the expected output of a programme” (Stame, 2004, p. 58). Black-box evaluations concentrate mainly on program outcomes, and often are purely descriptive, or rely on experimental or quasi-experimental research designs (Cook & Campbell, 1979; Shadish, Cook & Campbell, 2002). Although often carried out with great attention to methodological accuracy, these studies only provide information on the effectiveness of a program, often expressed in degree of goal-attainment, while processes leading to these effects are ignored. Since usually these processes are of great relevance in improving and implementing programs, black-box evaluations are only of limited use for practical purposes.
Today, though not undisputed (e.g. Scriven, 1991; 1993; Cook, 2000), theory-oriented evaluation has become a widely accepted and implemented approach for evaluations that aim to be methodologically sound and, at the same time, useful for practical purposes. It has become the theoretical basis for standard textbooks on evaluation (Rossi, Lipsey & Freeman, 2004; Weiss, 1998), and numeral practical guidelines have emerged (e.g. W. K. Kellogg Foundation, 2004a; 2004b).

2.2. Conducting theory-oriented evaluations of gaming simulations

What are the basic steps if one wants to conduct a theory-oriented evaluation? Reynolds (1998) developed a comprehensive approach that he calls confirmatory program evaluation. Its basic steps will be outlined below. Further helpful guides and examples for constructing and using logic models in evaluation can be found in Chen (1990, chap. 3-4), W. K. Kellogg Foundation (2004a; 2004b), Donaldson and Gooler (2003), and Yampolskaya, Neman, Hernandez & Koch (2004).

Reynolds (1998) proposes seven key steps in conducting a theory-based evaluation. The following list of steps is an adaptation of his concept for the evaluation of gaming simulations:

1. Use theoretical and empirical knowledge from gaming simulation literature, learning theory, and education to specify a logic model that shows how features of the gaming simulation, learner characteristics, and context conditions interact in generating the desired learning outcomes, as well as possible side-effects. If you are not involved in the game's development, consider the original developers' notions on the games' mechanisms that are relevant for learning as well.

2. Measure the effects of participation in the gaming simulation in regard to the logic model's outcomes, i.e. primarily learning results.

3. Collect data on mediating factors and key background factors, e.g. learners' previous knowledge, trainer characteristics, simulation features, gaming process, etc.

4. Estimate main effects of participation for the total group and any relevant subgroups.

5. If main effects are detected, test causal mechanisms of the logic model to explain them. If not, conduct causal analysis to understand lack of effects.

6. Interpret the pattern of findings to facilitate generalization and knowledge transfer.

7. Identify formative uses of findings for improvement.

The most fundamental step, which needs some further specification, is the first one. The development of a logic model is heavily dependent upon previ-
ous conditions of the gaming simulation that is to be evaluated. While for some simulations there may already exist a well designed theoretical basis, others are more experimental and intuitively conceptualized. In any case, determining a logic model not only requires reviewing empirical and theoretical knowledge on gaming simulations, but most often also involves interaction with the game’s developers and/or users. Useful techniques for supporting this process and for resolving possible problems are described in Weiss (2000), Chen (1990, chap. 3), Leeuw (2003), or Yampolskaya et al. (2004) [2].

With regard to the nature of gaming simulations one additional consideration seems important. Gaming simulations cover a wide range of forms, media, formats, content areas, and purposes, and are still difficult to structure in a consistent and comprehensive taxonomy (Klabbers, 2001). Greenblat (1981) counted 30 different claims that are made in reference to outcomes of gaming simulations. While some aim at narrowly defined learning goals, others pursue a set of very broadly stated general objectives. The question arises if the theory-oriented approach is equally suited for the evaluation of all of these different types. It is obvious that for rigid-rule games, which aim at a relatively closed set of learning goals, the theory-oriented approach should be easily applicable. However, developing logic models for more open, free-form games is probably much more demanding.

Yet, we would argue, the theory-oriented approach should be applicable in any situation where gaming simulations are used in an educational setting for learning purposes. From the viewpoint of educational psychology, any educational method should be based on more or less explicit goals and on explicable assumptions of how to attain them. So, if we fail to develop at least a basic logic model for a given gaming simulation, it has to be asked how we can reasonably expect learning to take place by participating in that game at all. So, even if for some games it is probably much harder to argue why, how, and under what conditions they contribute to desired learning effects, it should be no fundamental obstacle for applying the theory-oriented approach when evaluating them.

2.3. Advantages of theory-oriented approaches

What are the advantages of using theory-oriented approaches in evaluation? Why should we use logic models in the evaluation of gaming simulations? The following list tries to point out the basic benefits (cf. Rogers et al., 2000). It is organized roughly chronological, in that it follows some key stages of the evaluation process.

Choice of focus: As already mentioned, logic models can fulfill a guiding function during the early stages of the evaluation process. A well-designed logic model, that depicts how learning is expected to happen by participating in the gaming simulation, helps considerably in identifying the relevant questions and variables when designing the evaluation study.
Vague and distant outcomes: Programs often aim at outcomes that are difficult to measure and that are only expected as long-term effects. Gaming simulations, for example, often want to foster general skills like creativity or systems thinking. Since the logic model shows antecedent conditions for such long-term outcomes, it can help finding theoretically sound indicators for distant learning outcomes. So even if due to practical constraints of an evaluation study it is difficult to measure some of the desired outcomes, it becomes possible to draw some well-substantiated conclusions on their existence by looking at their antecedents.

Stakeholder participation: Normally, evaluators are at least to some degree dependent on the stakeholders’ [3] participation in developing a logic model for the program. This not only strengthens stakeholders’ involvement and interest in the evaluation process. One possible positive side-effect can be that practitioners, such as simulation designers or trainers, need to make their assumptions about the workings and effects of the gaming simulation explicit (Huebner, 2000). This can help improve the simulation even before the evaluation itself takes place, since implicit expectations have to be made explicit, and naïve and simplistic expectations are put into question.

Implementation monitoring: Since the logic model of a gaming simulation contains all factors that are considered relevant to make it work, it allows monitoring if these factors are in fact implemented during its execution. If, for example, the logic model of a simulation postulates that the induction of cognitive conflicts is crucial for players’ learning outcomes, it directs the evaluators to measure if these conflicts in fact are really present during the simulation.

Interpretation of results: If the evaluation proves the gaming simulation to be effective, the logic model helps locating causal explanations for found effects (Mark, Hoffman & Reichardt, 1992). Although it is never possible to “prove” a logic model (Weiss, 1972), it can be considered valid if two conditions are met: (1) At least some of the most important relationships postulated by the logic model have to be demonstrated to exist, and (2) alternative models, that could explain how effects are produced differently, have to be ruled out by theoretical considerations (Weiss, 1972; Davidson, 2000).

Understanding failure and success: Not only successful effects of a program can be analyzed via logic models for the causes of effectiveness. It becomes also possible to find explanations for cases when gaming simulations do not succeed. Sometimes a program has considerable merits, but fails to achieve its declared goals. Logic models can help to discover such otherwise hidden effects and supply information for future improvements.

Some caveats have to be mentioned, too. First, developing a logic model demands considerable content knowledge in the domain of the evaluated object (Chen, 1990). While more traditional method-centered approaches to evaluation could refrain from reflecting causal relationships and could ultimately confine to measuring input and output variables, developing a logic
model involves intense theoretical considerations. However, since in the domain of gaming simulations most evaluations are carried out by simulations experts, this should not pose a relevant problem.

Another caveat concerns unintended outcomes. Developing a logic model purely from the program’s viewpoint can make the evaluation blind for negative, as well as positive outcomes and side-effects that were not initially intended. This caveat seems appropriate in particular in regard to gaming simulations. For here, due to the open nature of the learning environment, learning processes are often even less predictable than in conventional settings. Scriven’s (1973) so called goal-free approach to evaluation reminds us that it might be advisable for evaluators to keep an open eye for such unpredicted outcomes and not confine to official aims. As a consequence, we must regard the logic that influenced program development and the logic from theoretical and empirical sources at the same time, when constructing a logic model (Davidson, 2000).

3. A theory-oriented evaluation concept for the business game Simgame

The first part of this paper addressed theoretical aspects of theory-oriented approaches to evaluation. In this section we aim to illustrate some central aspects of its application by presenting the logic model and evaluation concept for the business gaming simulation “Simgame”. Simgame is short for ‘Simulation game of economic processes and decision making’. It is a board-based business game in which participants form teams to simulate a company’s production and marketing cycles. The target group are students in economic branches in upper secondary education. The game’s development is a shared effort of project partners in six European countries, and is sponsored by the European Union’s educational program “Leonardo da Vinci” [4].

The overall goal of the Simgame project is to improve the quality of business education, particularly in the domain of entrepreneurial thinking, and thereby enhancing students’ employability and competitiveness on the European labor market. Two versions of the game are being developed: A so called “static version” where team-members only interact with each other and a “dynamic version” where teams compete with each other in a common market. A detailed description of Simgame is given in another paper (Weinert & Puschert, this volume).

3.1. Evaluation goals and questions

It has become increasingly clear over the years, that useful evaluations have to respond not only to the scientific community, but first of all to the needs and questions of those, who are its intended consumers and users (e.g. Stake, 1975; Patton, 1997; Leviton, 2003). Accordingly, after consultation with project partners and stakeholders, four goals have been set for uses of Simgame’s
evaluation: Raising *accountability* by controlling the project’s progress and documenting its outcomes, supporting *development* of Simgame by revealing possible points of improvement, assisting *decision-making* by facilitating decisions on implementation of Simgame, and promoting *scientific progress* by gathering knowledge for future projects.

From the scientific point of view, the main goal of the evaluation is to not only to study the effects of Simgame, but also to highlight the mechanisms that make participation in it a successful learning experience. The following questions are the key questions that the evaluation aims to answer: (1) Which cognitive, affective, behavioral, and social learning effects result from playing Simgame? (2) Under which conditions can learning effects be optimized? (3) Are there areas of improvement of Simgame? It becomes clear that the theory-oriented approach is particularly promising in regard to answering the latter two questions.

### 3.2. Logic model of Simgame

Figure 1 shows the logic model, that has been developed for Simgame, according to the procedure described above. Similar to most logic models, it follows a basic input-process-outcome logic. Outcome is divided in short-term and long-term outcomes.

![Figure 1: Simgame Program Theory](image-url)
Considerable efforts were put into discussing the program logic. The intended goals of Simgame, in particular, have been discussed to reasonable length with the simulation’s developers, intended users, and experts in the domain of gaming simulation and business education. The resulting list of cognitive, behavioral, affective/motivational, and social learning goals of Simgame now represents central parts in the outcome section of the logic model. The other parts of the model have been constructed on two bases: Existing documentation of the project concept and theoretical and empirical knowledge from the literature. Below, we give a short list of theoretical and empirical knowledge that has been used in conceptualizing the Simgame logic model.

From gaming simulation literature we used theoretical models, that describe how learning takes place in active learning and simulations environments. In particular, the model of Garris, Ahlers & Driskell (2002) was helpful, in that it provided the basic input-process-outcome logic in the context of gaming simulations. Empirical findings on factors relevant for learning with business simulations were derived from overview articles, such as Faria (2001), and Wolfe (1997), as well as more recent research (e. g. Hindle, 2002). They mainly provided insight into correlates of gaming performance, e. g. team cohesion and instructor involvement.

Literature on instructional quality was used to shape the broader context of learning with Simgame. We adapted parts of Ditton’s model of school and instructional quality (Ditton, 2000; 2002) to extract more general factors of learning in school contexts. In a similar manner, we adapted parts of a framework model for learning in virtual seminars (Friedrich, Hron & Hesse, 2001), since it emphasizes the role of interaction with technology in learning processes, which in our context is represented by Simgame. Both models are based on empirical evidence, so that we believe to have captured the basic possible influences that might become relevant in learning with Simgame.

From learning psychology literature we obtained relevant factors for individual learning processes. Here, we concentrated on instructional theory based on a moderate constructivist view of learning (Hense, Mandl, & Gräsel, 2001), since they emphasize authenticity and problem-solving as key features to learning success. Additionally, Kolb’s (1984) experiential learning cycle has provided valuable insights, since it too is easily applicable for the analysis of learning in simulations (Kriz, 2000).

4. Conclusion

The primary question this paper has tried to answer is: ‘What is the right way to conduct evaluations of gaming simulations?’ By raising this question we do not mean to claim that there is one single right way. After all, designing an evaluation study is heavily dependent on many context factors, and above all on the intended purposes of the evaluation study (cf. Chelimsky & Shadish, 1997; Stufflebeam, Madaus & Kellaghan, 2000). Yet, we argue that for the evaluation of gaming simulations, as well as for the evaluation
of other kinds of educational procedures or social programs, the theory-oriented approach has some remarkable benefits in many contexts. It proposes a frame of action that directs evaluators’ attention to a more holistic understanding of the how and why of learning with gaming simulations.

From a meta-analytical viewpoint, the theory-oriented approach offers an additional advantage. Normally, evaluation studies allow only conclusions about the specific gaming simulation studied. However, if different studies use similar logic models, their results can be much better compared to each other and synthesized in meta-analysis (Glass, McGaw & Smith, 1981; Lipsey, 2002; Petrosino, 2000). Thus, it should become possible to generate more generalized knowledge on the causes and mechanisms that make gaming simulations successful.

The logic model of Simgame is a first endeavor to create a logic model for a concrete business game. While there are certainly some factors in the model that are specific for Simgame or to the domain of business games, many others are more general and should be suited for numerous other gaming simulations. We are aware that our model is far from being complete and that it remains to be seen how it stands the test of time. Yet, we see it as a first step towards the development of a more general theory of gaming simulations as learning environments, and thus to a more general understanding of learning in gaming simulations.

Notes

[1] The term „program“ in evaluation literature refers to all kinds of procedures that aim at planned social change, including educational methods and learning environments such as gaming simulation (Rossi, Lipsey & Freeman, 2004).

[2] There is an interesting parallel between logic model development in evaluation and model building in gaming simulation. Often, in developing computer-based gaming simulations, techniques of system dynamics modeling (Forrester, 1961; Bossel, 1994) are used to map that section of reality which is to be simulated in the game. These simulation models are in many ways similar to logic models in evaluation, since they, too, show how different variables interact and influence outcomes. Both are abstract representations of reality which reduce its complexity to a degree that we can reasonably manipulate (in gaming simulations), respectively analyze (in evaluation). Thus, it might be a promising effort to try to apply techniques of system dynamics modeling to the development of logic models in evaluation. However, to our knowledge no such attempts have been made up to now.

[3] The term „stakeholder“ in evaluation literature usually refers to all persons associated with a program (Joint committee on standards for educational evaluation, 1994). In gaming simulations this includes game designers, trainers, participants, and possibly administrative staff.


References


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