A Comparison of Simulation-Based and Conventional Training Methods

> *"Conventional teaching methods are usually considered valid until proven otherwise, whereas the effectiveness of innovative methods must be amply demonstrated before they receive the support or approval they deserve.*[1]*"*

A growing chorus of practitioners sing the praises of simulation-based training. As pinched budgets drive managers to scrutinize the return on their training investments, the question is, are simulation-based methods more effective than conventional training methods, such as classroom-based and traditional e-Learning? That is, do they result in greater retention, deeper understanding, higher levels of engagement, and better transfer of know-ledge to the job?

This paper summarizes research that addresses this question.

Comparison Conundrum

Before going further, it's important to recognize the inherent challenge in comparing simulation-based and non-simulation-based training methods[2].

The first challenge might be called the "apples-and-oranges" effect: simulation-based training generally focuses on *apply-ing* knowledge, while lectures and most elearning focus on *imparting* information and abstract knowledge (such as princi-ples). If they teach different things, how can the outcome of one be meaningfully compared to the other? Studies must be very careful in how they equate outcomes.

Second, training is situation-specific, dependent on the audience, the means by which it's delivered, the content being taught, and the design of the instruction. This makes it hard to generalize from one context to another. Few would argue that a badly-designed simulation is better than a well-designed classroom experience. Bredemeier and Greenblat write "…what anyone learns from any experience depends on a host of circumstances: what the person is looking for; the detailed "shape" of the experience; the nature of the person; opportunities to practice; similarities of that experience to other experiences; the intrinsic pleasantness/unpleasantness of the experience. Such variables obviously affect what we all learn from any exper-ience, whether it be a lecture, a cocktail party, or a movie; and it should be clear that they affect what people learn from a simulation….[3]"

Meta-Analysis on Simulation-Based Training Effectiveness

In light of these challenges, this paper focuses on "meta-analyses," that is, re-search that examines a group of studies meeting some criteria, with the purpose of trying to discern general findings across them. This broadens the implications and removes some of situation-specific effects involved in individual treatments. The find-ings are summarized here; if you wish to view the actual analyses, consult the bibliography at the end of this paper.

In this research, "role-play simulations," "simulation-games," and "games" all mean the same thing: one or more learners are placed in a realistic situation and given one or more goals, and are left to achieve those goals as they see fit.

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[1] St-Germain, Michel and Dany Laveault (1997), quoting Cathy Greenblat. See Greenblat (1975) for a reference to the quotation they paraphrase.

[2] See Feinstein and Hugh Cannon (2001) for a deeper treatment of this conundrum and a proposed solution to it.

[3] See Bredemeier and Greenblat (1981) in the bibliography.

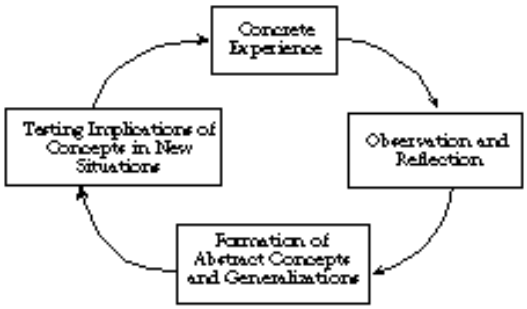
Wolfe (1997) examined a variety of studies on simulation-games to teach strategic management, from the 1970's to 1997. His conclusion? "**Ample evidence has been presented authenticating the effectiveness of computer-based general management games as vehicles for teaching strategic management. In every study cited, the particular business gaming application produced significant knowledge-level increases**. When the business game method was pitted against the case approach, and when case-based evaluation criteria were not employed, **the [simulation] approach was *superior* to cases in producing knowledge gains**."

David Pierfy (1977) reviewed 22 research reports that compared simulation-based treatments to conventional ones. Eleven of those studies assessed retention of knowledge by administering a post-test a second time, well after the training had been completed. Of these, 8 studies found that **retention was significantly better with simulation and gaming than with conventional lecture/study approaches**. Further, 8 of the 22 studies compared student interest in the subject matter, and 7 out of those 8 found **significantly higher interest reported by students participating in the simulation,** than those in conventional training.

Bredemeier and Greenblat (1981) synthesize the findings of Shade and Paine (1975), writing that they "…found **more effective *transfer* of information through simulation than through conventional methods…."** [author's italics] They conclude "in sum, the available evidence suggests that simulation/games are at least as effective as other methods in facilitating subject matter learning and are more effective aids to retention…the available evidence thus suggests that, under certain circumstances and for some students, **simulation-gaming can be more effective than traditional methods of instruction in facilitating positive attitude change toward the subject and its purposes**."

This finding is echoed in Rosenfeld (1975), who writes that "although it is difficult to measure, **there are many reports that simulation games significantly increase the motivation and interest level of student players**." He adds "simulation games probably have the most potential in the area of affective learning. It seems logical to believe that experiencing the world of others would be more effective in increasing empathy and understanding for others than traditional teaching methods and might lead to changed perspectives and orientations," though he admits that recent evidence in this area is ambiguous.

Kolb (1984) has laid out a model for how people acquire knowledge in an experiential learning environment. Briefly, Kolb's model has learners working through 4 phases, which are ideally iterative, as shown in the following graphic[4]:



Learners start by engaging in a situation (concrete experience), then they observe their behavior and reflect on it. From this, they generalize and develop abstract concepts, which they then return to the field to test by applying them to new situations.

Herz and Merz (1998) used this model to analyze dozens of studies comparing simulation-based and conventional methods. From this, they conclude that "…**simulation/game seminar outperforms a conventional seminar with respect to all aspects of [Kolb's] learning cycle**. The advantage is relatively small in

[4] See Center for Teaching and Learning (1996) for the original publication of this graphic.

the Concrete Experience phase, and it is relatively large in the phases of Abstract Conceptualization and Active Experimentation…simulation games support especially those aspects of learning that involve creative search, active involvement, and social interaction…. Although the reliability of the test has not been checked formally, a number of observations indicate that the applied test procedures are indeed reliable…**the experimental results also support the idea that learning is by its very nature not only a content process but also a holistic process**. Learning does not only mean mastering complex theories with certain techniques but also mastering human interaction, derivation of implications, confrontation of ideas, and enforcement of strategies. Thus, the process of learning can be enriched by providing students with an environment in which they cannot only rethink economic ideas but in which they can also experience the whole decision-making process in economics policy…. The empirical results indicate that simulation-games can be an efficient tool to create, supply and control such a form of interaction."

In a well-known treatment of the subject, Enrico Hsu (1989) is even more blunt. "**The message that the management game is a powerful tool for experiential learning of managerial skills is rather unequivocal,**" he writes. Based on the research, he advocates use of simulations and simulation-games, but cautions that they have a specific role in the curriculum. "With the sharp decline of computer costs and the significant progress of computer applications, such as computer-enhanced communication systems, artificial intelligence, semantic databases, model management systems, and hypertext, the prospect of using computerized management games, in its broad sense, for management education and development becomes brighter than ever. However, to ensure the effectiveness of playing management games, we must have a clear and explicit hypothesis on the specific learning objectives. While it is acceptable to use management games to enliven the presentation of concepts, it is most effective to adopt the management games to acquire managerial, technical, and problem-solving skills, based on the experiential learning principles." For example, he points out that "…cognitively, gaming does not lend itself to the efficient learning of theoretical abstractions and principles because of the presence of distracting trappings. That must occur by another method. Rather, gaming lends itself to the pragmatic interpretation of a general principle in a specific situation."

Wachter (2003), in an examination of studies on the use of simulations in medical training, concludes that **"simulators can effectively identify errors and appropriateness of decision making,"** in areas such as anesthesiology, radiology, and surgery. The report points out that in many areas of medicine, simulations are the *only* means by which physicians can practice procedures without life/death consequences (including making and recovering from mistakes), and it also gives them exposure to rare situations they don't normally see in the field. These two advantages can make simulation-based training more beneficial than even on-the-job experience!

Individual Studies

Numerous studies have found particular simulation-based treatments superior to conventional methods. However, as said before, given that how one learns depends on the context and subject matter, it's difficult to generalize from these studies. Nonetheless, a few individual studies are included here as illustrations of the specific findings on which the meta-analyses described earlier were based.

Agnew and Shin (1990) conducted a study to compare simulation-based and conventional training in mechanical instruction, specifically, the operation and maintenance of electrical and hydraulic tractor components. One group received simulation-based training, while the other had hands-on exposure to the actual components. The experimenters tightly controlled the groups and the execution of the training to weed out discrepancies (e.g., all

were juniors, training was started on Monday and completed on Friday, etc.). What they found was that the "the lack of significant differences in the cognitive test scores of students should be viewed as a positive indication of the effectiveness of simulation as an instructional technique." In other words, **students learned as much from a simulation as they did from actual hands-on experience.**

Charles Petranek (Petranek 1994) conducted a study involving two social psychology classes. Both classes had the same type and number of students, used the same textbook, and were given the same tests. One class was taught entirely via simulation, while the other was taught via traditional lecture and discussion. Petranek gave the classes three tests over the course, and the aggregate scores compared. Petranek found that "…the simulation class with no lectures had statistically higher scores on the multiple-choice questions than did the traditional class…research thus supports [the fact that] **social psychology students learn more with simulations than they do with lectures."**

Lane and Tang (2000) compared the teaching of statistical concepts via simulation versus traditional methods. 115 Rice University undergraduates took part in the study. They found that "**training by simulation led to better performance than training using a traditional textbook approach**. Subjects trained with the simulation were apparently more able to recognize key elements of the ill-defined problems embedded in various real world situations and apply the relevant statistical principles. This provides support for the thesis that simulation is effective for training on educational and cognitive tasks (as opposed to tasks such as flying an airplane where simulation has been shown unequivocally to be effective)."

Indirect Evidence of Simulation-Based Training Effectiveness

Another argument supporting the claim that simulations are more effective than conventional training methods stems from their growing prevalence in business and academia.

As pointed out above, simulation-based training is so ubiquitous in flight school that its superiority as a training method is a given. Furthermore, simulation-based training is a predominant method of instruction in the armed services of the United States and much of the world. In fact, the U.S. military has thousands of personnel dedicated to developing and refining simulation-based training. In these areas, the superiority of simulation-based training over conventional methods has been established for so long that it is no longer questioned.

What is more surprising is the ubiquity of simulation-based training in business management classes. A survey conducted by Faria (1998) found that **97.5% of accredited business schools include simulation-based training in their curriculum**. 65% use simulation-based training in business policy courses, 63% in marketing, and 44% in management. What's more, **a survey of instructors using simulations in their classes rank them as the most effective means of train-ing**, well ahead of the case method or lectures (specifically, business games were ranked 7.9 on a 10-point scale with 10 being best, while cases were ranked 6.8 and lectures, 5.9).

Medical schools also use simulation-based training: "**71% of medical schools in Canada, the United Kingdom and other western nations used mannequins or some other form of simulator** to teach anesthesia to medical students" (Wachter 2003).

A survey of **training managers with companies having 500 or more employees found that over 60% of them use role-play simulations in at least some of their training**. If these findings are extrapolated across the U.S., this means that over 8,000 businesses are using simulations to train.

The Verdict is In

A sizable body of research suggests that simulation-based training is generally superior to conventional training methods. Even in light of the challenges in comparing approaches, and the situation-specific nature of training, numerous studies have demonstrated that learners undergoing simulation-based training achieve deeper understandings, retain knowledge longer, show a greater interest in the subject matter, and are better able to transfer their learning to their job than learners who undergo conventional training methods.

Thus, in order to maximize their training investment, many organizations are moving to simulation-based training. Since it provides deeper, more lasting learning, it will have a greater impact. It can provide greater potential value in achieving an organization's goals than can traditional e-learning. Since an organization often has only one crack at making learners smarter, it makes sense to go with the training approach that has the highest probability of learning gains.

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