Lehrstuhl für Wirtschaftspädagogik
Univ.-Prof. Dr. Klaus Beck · Univ.-Prof. Dr. Klaus Breuer
Fachbereich Rechts- und Wirtschaftswissenschaften
❍ Reihe: Arbeitspapiere WP ❍

49

Klaus Breuer / René Molkenthin / Robert D. Tennyson

Role of Simulation in Web-Based Learning

JOHANNES GUTENBERG-UNIVERSITÄT MAINZ

Herausgeber:

Lehrstuhl für Wirtschaftspädagogik
Univ.-Prof. Dr. Klaus Beck
Univ.-Prof. Dr. Klaus Breuer
Fachbereich 03: Rechts- und Wirtschaftswissenschaften
Johannes Gutenberg-Universität Mainz
Welderweg 9
D-55099 Mainz
Telefon: +49 6131 392-2009; Telefax: +49 6131 392-2095
email: beck@uni-mainz.de
klaus.breuer@uni-mainz.de

Breuer, K. / Molkenthin, R. / Tennyson, R. D. (2004): *Role of Simulation in Web-Based Learning*

KLAUS BREUER / RENÉ MOLKENTHIN / ROBERT D. TENNYSON

Role of Simulation in Web-Based Learning

Role of Simulation in Web-Based Learning

Klaus Breuer and René Molkenthin,

Johannes Gutenberg-Universität Mainz

Robert D. Tennyson,

University of Minnesota

Invited Chapter for:

Measurement of Problem Solving Using Simulations

Edited by
Eva L. Baker, UCLA/National Center for Research on Evaluation, Standards,
and Student Testing (CRESST)
Jan Dickieson, Naval Health Research Command
Wallace Wulfeck, Space and Naval Warfare Systems Center and Office of Naval Research
Harry O’Neil, University of Southern California/CRESST

Hillsdale, NJ:.Lawrence Erlbaum Associates

Abstract

Growth of Internet technological provides an opportunity to extend simulation-based instructional approaches into web-based formats. Web-based formats allow the dissemination of simulations to users at any workstation throughout the Internet environment. The lowest level application format provides for downloading of simulation programs. This makes use of the Internet as a distribution platform only. More enhanced approaches target the interactive use of a simulation via the Internet. At its core the interactive solution comprises three basic elements: a model on a server, a network-connection, and a GUI (Graphical User Interface) within a browser. The realization of such a set-up is not a trivial task but from the authors' perspective it does not provide an educational asset in and of itself. The technical platform is a necessary prerequisite; any educational approach is dependant from its functionality. However, meaningful teaching and learning activities need more than a technical platform. They require a foundation in learning-teaching theory. Web-based simulations need design approaches making use of both simulation tools and learning foundations to achieve significant objectives of learning. This orientation defines the perspective of this chapter.

Role of Simulation in Web-Based Learning

Simulations and games have been an area of interest and development since the early days of computer-based instruction and learning (1960s). Biological, physical, economic and social phenomena have been depicted within *models* that are executable on a computer. Such phenomena can be derived from a real, a theoretical or a fictitious ground. Regardless of content, a more or less sophisticated interaction component enables students to access the model, to change parameters, to modify routines, or even to modify the structure; and, to receive feedback on the status of the model reflecting the various types of interventions (Bitzer, Sherwood, & Tenzar, 1972; Eyfert, 1974). The interaction between the user and the model occurs in a sequence over time. From interactions over time, the student acquires knowledge, skills, and/or strategies about the content depicted and its dynamics.

From those early simulations, there has been a continuous stream of developments enhancing and creating new design approaches (compare Bork, 1980; Edwards, 1995; de Jong 1991). Outcomes of these efforts over the past decades are readily seen in the application of simulations in technical skills education and training. For example, railroad engineers are trained to run today’s high-speed trains via simulators. Mechanics are certified for the utilization of CNC (Computer Numerically Controlled)-technologies based on exercises with simulators. Business executives improve their decision making in complex, dynamic markets based on business games or on market simulators. Students acquire knowledge and skills in subject matter domains based on (simulated) micro-worlds. The number of simulation examples is almost endless. There is application variance in respect to levels of fidelity between simulations. The successful integration of analogue media into the digital format is an example of contemporary differences. The level of fidelity presented within simulations has been extended to the full multi-media repertoire.

In addition, learning based on simulations is backed up by the growing use of simulations as research and development tools. An example from research is given in the studies on complex problem solving abilities performed in psychology (Tennyson & Breuer, 2002). Experimental subjects are requested to cope with complex, dynamic environments represented by means of micro-worlds. The research end is not findings in instructional design but the study of human problem solving abilities. This includes the study of learning activities within problem solving activities, but not primary from an educational perspective.

An example of developmental activities is given in the optimization of a car production process by means of a systemic simulation program. Here the simulation is considered a tool for optimizing a technical process. There are learning processes included during the phase of the development of the model. However, learning is not primarily seen from an educational view, but rather from the perspective of knowledge management within an organization.

Given that background and the growing technological milieu, there is no surprise about the extension of simulation-based instructional approaches into web-based formats. The formats allow the dissemination of simulations throughout the Internet to users at any workstation within the web environment. The lower level application formats provide for downloading of simulation programs. This makes use of the Internet as a distribution platform. More enhanced approaches target the interactive use of a simulation via the Internet. The technical solution has been achieved since the development of the World Wide Web in the early 1990s.

At its core, the interactive solution comprises three basic elements: A simulation model is run as a resident on a central server. A data exchange process is established via the Internet or an intranet providing the necessary interaction between the user and the model. The network-connection makes use of a standard browser providing a Graphical User Interface (GUI). The GUI represents the status of the model and the variables on which the participant can make her or his decisions. The three elements, a model on a server, a network-connection, and a GUI within a browser, establish the necessary technical basis for using simulations at any workstation on the web or on any notebook in a wireless LAN. The realization of such a set-up is not a trivial task but from the authors' perspective it does not provide an educational asset in itself. The technical platform is a necessary prerequisite; any educational approach is dependant from its functionality. Meaningful teaching and learning activities however need more than a technical platform. They require a foundation in learning-teaching theory (Tennyson, 2002). Web-based simulations need design approaches making use of both simulation tools and learning foundations to achieve significant objectives of learning. This orientation defines the perspective of this chapter.

The proposed approach looks first at the framework of objectives for using simulations in educational environments. It addresses basic types of simulations in accordance with such objectives. It reflects on the approach to use simulations as a tool for problem-based teaching-learning activities. It refers to the notion of adaptivity for customized interaction processes. Such interaction may be established by using real-time, intelligent 4th generation instructional design evaluation (Tennyson & Foshay, 1998). This demand feeds back into requirements for the architecture of web-based simulations. A basic assumption in the argumentation is that the web-based approach to simulations can bring a major technical advantage. The use of a central server can make available processing speed and processing capacity with almost no limits for web-based simulations. At the conclusion of the chapter, we look at perspectives towards research in applied educational settings and towards large-scale assessment.

The background of our argumentation is derived from three disciplines. First there is a root in educational psychology. Second, there is a link to educational technology. And, third, there is a tie to vocational education and training (VET). The latter may result in specific arguments and examples that differ from general education. We trust that the reader has a chance for drawing generalizations and for transfer into other educational domains.

Objectives for Teaching-Learning Processes Based on Web-Sims

The spectrum of potential learning activities is extensive. Among these activities there are the acquisition and recall of knowledge, the automation of motor as well as of cognitive skills, the construction of problem solving strategies, the elaboration of methods for learning or meta-cognition, the development of transfer strategies, the shaping of attitudes, the enhancement of motivation and interest, the creation of mental models, and the modification of behavior. From an instructional design perspective (Merrill, 1997), this variety of learning activities should be analyzed to identify distinct classes of outcomes and then define specific teaching methods and strategies that will effectively result in the desired outcome of learning.

Our perspective on the use of web-based simulations is that in general they do not focus on narrow, specific results of learning. They rather open up a spectrum of potential objectives, which can be targets of learning. The set-up of web-based simulation approaches needs a major investment in educational design and development as well as in information technology. The latter will provide its best return when teaching approaches are open and when they allow options for the set-up of learning environments. The options can stress different objectives. An example may be given by the time a simulation becomes used in a learning activity. That is, a web-based simulation can be offered at the beginning of a learning activity as a source of motivation for follow-up study efforts on the subject matter. Within that approach a web-based simulation may also function as an *advance organizer* for follow-up learning.

A web-based simulation may be used for studying the model that it is based on. This way a core objective can be the development of an appropriate mental model, which allows perceiving the variables involved, their interrelations, and the corresponding dynamics. The mental model may become the basis for decision-making processes within the simulated as well as in the real, depicted environment.

A simulation may also be used at the end of a learning activity for assessing the level of performance achieved by a student. This can be done, for example, by exposing participants to a scenario at a specific level of difficulty. The three approaches (advance organizer, mental model, and assessment) may make use of the same simulation environment. The decision for using a specific approach is up to the *user* given that the simulation environment allows such an open approach.

The use of web-based simulation-environments can target different objectives. Without the attempt at being a comprehensive list, such objectives may read:

- Acquisition of structural knowledge,
- Development of domain-specific problem-solving competencies,
- Elaboration of holistic views toward complex phenomena (systems thinking),
- Fostering of subject-matter interest and/or meta-cognitive competencies (self-regulation, self-monitoring),
- Support for the ability of role-taking, and
- Build-up of the ability for coping with dynamics.

The acquisition of structural knowledge points to the need of making knowledge and skills applicable in a flexible way. Concepts, which become merely memorized, can hardly be used in the process of explaining a certain situation. Likewise, skills, which become acquired as a mechanical, not situated procedure, can hardly be used for performing within a specific context (Renkl, Gruber, Mandl, & Hinkhofer, 1994). Such components of knowledge have to be linked within semantic networks. They have to be contextualized. In addition to the conceptual and the procedural facets of knowledge, learning needs the contextual or conditional component. Knowledge becomes applicable in a flexible mode, when it becomes used in varying situations. When students can apply concepts and procedures within different situations and can elaborate on the usefulness and appropriateness of such experiences, they can construct a flexible, structured knowledge base. One efficient way of providing respective contexts can be through the use simulations in learning environments.

The ability to perform in specific (work-place) situations is certainly but not only rooted in the availability of elements of knowledge. It also needs approaches of how to tackle tasks and how to proceed through a sequence of steps. An early model illustrating this problem-solving concept is the TOTE unit defined by Miller, Galanter, and Pripram (1960). Based on a sequence of status explorations (**t**ests) and operations a person performs in a larger task, the overall task becomes decomposed into sub-tasks. A specific sub-task is executed (**o**perated on) until it has been accomplished (**t**est and **e**xit). This includes the knowledge of when to test what against which standards. The result is to start working on the next sub-task. Such sequences of performance can become automated. The result is the built-up of schemata in the sense of Piaget, which can be used adaptively to varying situations. The development of schemata needs to be repeated in experiences within varying contexts. Simulations are one approach to provide the necessary repetition in the required variations. When schemata become applied to newly encountered needs they provide a basis for domain-specific problem-solving activities.

Human problem-solving activities have a tendency for failure (Doerner, 1996). Among the reasons for potential failure are the tendencies for linear, causal inferences as well as the neglecting of side effects and undesired long-term effects within decision-making for complex, dynamic environments. Approaches for counteracting this tendency are given within *system dynamics* (Forrester, 1968) and within *system thinking* (Senge, 1990). Both highlight the specifics of complex, dynamic environments, which incorporate, among others, delays over time, non-linear interrelations between variables and feedback processes within systems and thus are likely to confront problem-solvers with counter-intuitive system behavior. System thinking highlights the notion of systemic, not just systematic, structures of complex processes. System dynamics adds the aspect of modeling to these structures for the purpose of simulating the corresponding dynamics. Both refer to the concept of mental models (Johnson-Laird, 1983, 1988) as basis for action within solving complex, dynamic problems. In this respect, Senge points out that, “*Mental models* are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take act action (1990, p. 8).” Such mental models are highly resistant against changes. For modification, they need alternative, powerful models which may be provided by active modeling and simulation-based learning activities (Hillen, 2004).

The motivational effect of simulation-based learning activities is well recognized (Jonassen & Tennyson, 1997). This is one reason for their long-term use in education. The strength of such motivational effects becomes obvious from reports on flow-experiences within simulation-based learning processes. Motivation is considered to contribute to problem-solving activity in a significant way (O’Neil, 1999). Processes of planning and of self-monitoring can be elicited within simulation-based learning activities. They can give room for self-reflection and for external feedback on such processes. This construct of motivation is beyond conventional objectives for teaching. Nevertheless, we consider motivation to constitute one specific potential of educational simulation use.

Web-based simulations can give access to problem-solving processes from different perspectives. For a single learner this may be achieved by being assigned to different activities within a given simulation. In local networks this can be extended to assigning activities to different learners who have to compete or to collaborate in respect to the objectives of the simulation. Web-based installations can extend this option for role taking into the distance. This can be accomplished both in an asynchronous as well as in a synchronous design. Role-players can compete or collaborate in indirect or in direct electronic contact with their co-agents. In this respect technology can provide a significant contribution to this field.

Finally, a primary objective of educational simulations from its first roots shall not be omitted. That is, the exposure of learners to the dynamics of processes. Whether there is a market-process, a chemical process, a physical process or a technical process, in each case there is a development of a system over time that a learner can experience and into which she or he can intervene by means of given variables. Such dynamics in a lot of cases can hardly be studied in real settings, due to their restricted accessibility. This can allow for learning processes at the skill level, it can allow for problem-solving activities, it can allow for processes of self-reflection, it can represent a subject matter in a mode which attracts attention and evokes motivation and/or interest. This can result in the development of specific skills in a playful as well as in a serious approach.

Web-based Approaches to Simulation Design

In the early applications, simulations were used primarily within military, political, and economic scenarios for the purpose of decision-making support. That way, risky and costly strategies could be analyzed and evaluated in respect to probable consequences. The option of testing and evaluating the probable results of decisions without being faced with the outcomes from failure made simulations an interesting tool for education and training. For instructional purposes, the significant structures of a real world environment can be depicted within a model. Learners can intervene into the model by means of decisions and can observe and evaluate the consequences of these decisions. The conclusions of each decision (or set of decisions) constitute the basis for follow-up decision-making. The model used can be defined at a qualitative as well as at a quantitative level. For example, in an economic model the effect of workers' wages are often more related to quality of the work environment (i.e., qualitative) than monetary variables (quantitative). In reference to Wilbers (2001), we will address web-based approaches of technical simulations, business simulations and games, modeling, role-playing exercises, case studies, micro-worlds, and animations.

Technical Simulations

Simulators represent a *technical simulation* system within a model. The learner can manipulate the variables of the model directly. For that, the model depicts the regulation and adaptation processes within the real system. That way, the learner can improve through training the handling (process control as well as maintenance) of the system. Specific procedures can be trained and automated. Errors in handling the system have no impact on the real system and thus do not cause negative consequences like cost, damage, or loss. This allows for testing of new procedures as well as of risky or dangerous ones. CNC-simulators, which represent the functions of automated drilling, metal shaping or wood processing machines, can include the option for transferring *debugged* procedures of code to a real machine. This provides realistic feedback to the trainee. In *virtual* laboratories, the performance of the real equipment, based on the learner's commands, is represented by means of animations. This includes handling and measurement processes and can reduce the need for manipulative skills on the learner's side. Because these approaches are computer-based to begin with, this makes it possible to represent the learner/system interaction in a web-based approach, given the necessary IT-technology.

Business Simulations and Games

Two defining features represent the *business simulations and games* approach. There are a model-based simulation component and a game component. The model-based defines the task environment with its basic structures. This does not include the *social* aspects of the situation. Learners who have to perform in respect to the given knowledge base, the defined communication, and the decision-making processes control the social variables (Capaul, 2001). The outcomes from these processes, the *decisions,* are entered into the simulation model. Decision results are calculated and represent the *environmental* conditions for the follow-up period of social interaction. This may comprise only one or more social parties playing/competing against each other on a virtual market in a sequence of several periods. As there are a huge variety of such simulations and games, reflecting all kinds of markets, industries, strategies, and highlighting the two sides of the approach, there is the distinction between *tactical-decision simulations* and *social process simulations* (Gredler, 1992). The first highlights the systematic approach to information retrieval and uses within decision-making. This approach is included in many business games. The category of social process simulations stresses the interaction between learners and their references to attitudes and values. Learners have to act upon a defined role within a social framework and are requested to solve a given problem by means of specific interaction processes (Haritz & Breuer, 1995). Technological support can be given to this approach by means of web-based discussion groups and by video conferencing. However, there may be restrictions to personal interaction processes especially in respect to non-verbal communication. Highflying technologies based approaches in military systems and in corporate settings, are referring to this approach in terms of an electronic *war-room*.

Modeling

The *modeling* approach refers to the active development and/or elaboration of models to represent a given system. Within this approach, the previously addressed approaches of *system thinking* and especially of *system dynamics* come into play. Following the modeling of a system is the study of its dynamics in simulation runs. A simulation construction process includes the analysis of the system behavior, which may provide reason for redefining or enhancing the model in respect to the representation of a certain aspect. Alessi (2000) refers to these two activities by applying the labels, *building and using models*. Both activities are considered to contribute to the development of refined mental models for acting within the respective system (Hillen, 2004). Of special relevance here is the aspect that both technical and business simulations are based in models of the underlying system. The construction of the model is a necessary prerequisite for the simulation of the system. What makes a difference, however, is the degree of transparency that is associated with the modeling approach. Most technical and business simulations are based on *black-box* models, which are defined by their programming language code. Such code in addition becomes compiled and is stored in binary format. There is no need for explanation in respect to the *readability* of it for any user. The alternative is to make use of a systems dynamics based modeling tool. This allows for the development of *glass-box* models or at least *opaque* ones, which the user may access for elaboration of her or his mental model on the simulated system (Breuer & Berendes, 1999). That way, in addition to the process of building and refining models, the system itself can be of educational relevance. Open, glass-box models can also support participants using technical and business simulations in the process of developing valid mental models for their decision-making process in running such simulations.

Role-Playing Exercises

As stated in respect to business simulations and games, the social aspects of decision-making processes can be considered in simulations (Haritz & Breuer 1995). For example, a learner takes over a role, which he or she is not yet familiar with, and experiences a situation from an unknown perspective. This is meant to improve the ability for empathy (Capaul, 2001). A significant aspect of role-playing exercises is the option for a repeated experience of social situations and their analysis in respect to alternative interpretation and perception. Role-playing exercises do not necessarily depend on a technical platform. The web comes into play when there is support from discussion groups (Wilbers, 2001) or when interactions become based in video-clips offering options to the learner for tactical decisions in social processes. This for example is used for the training of sales strategies or for counseling processes (Schwarzer & Buchwald, 2001).

Case Studies

The fifth approach, *case studies,* originates from law-studies and is based in the casuistic methodology. At the Harvard Business School the approach has been adopted to business administration studies. From that basis there is transfer into additional subjects especially for fostering problem-solving abilities (Frey, 1995). Cases represent authentic, that is from specific professional demands, derived problems. Students are to solve these by defining respective measures. Here too the decision-making situation is handled in the approach of a simulation. Also, there is no direct need for technical support. There are, however, more and more approaches for support of the case study approach within the Internet by means of corresponding web pages and by video clips.

Micro-Worlds

The concept of computer-based micro-worlds has been introduced in education from at least two perspectives. One is from the context of the first *revival* of computer-based teaching and learning activities in the early 1980s based on the newly emerging microcomputer technology (Bork, 1980). In this respect the statements on simulators and on business simulations and games given above can be applied without essential differences. The technical platform has been stand-alone microcomputers. The options for graphical representation were low level but were emerging. The major educational advantage can be considered in the better accessibility of the technology within educational settings, which could provide an interactive access to simulation-based learning activities. This has been one of the lines of developments already addressed in the introductory statements.

The second perspective is from psychological research on complex-problem solving as initiated by the workgroup of Dietrich Doerner (1996) in Germany. For a brief orientation on these works the reader can refer to O’Neil (1999) and Frensch and Funke (1995) respectively. The basic purpose of this approach concerns the performance of individuals or of small-groups of people in complex, dynamic, and at least partly transparent environments, as many all-day situations people have to act in are considered to be. This approach too was based in the emerging microcomputer technology. It has made use of simulation programs in order to represent the problem-solving space the subjects of research have been confronted with. In the beginning subjects had no direct access to the respective computer-based model, but have been monitored and advised by a mediator. This has been modified with the emerging user-friendliness of technology and with the transfer of the approach into the field of management diagnostics (Frensch & Funke, 1995) and into the field of teaching/learning activities (Breuer, 1983; Breuer, 1985; Breuer & Kummer, 1990).

Here too there is no basic difference to the characteristics given before in respect to business simulations and games. In fact some of the simulations used for complex problem-solving research have been grounded in scenarios from business administration.

Animations

Computer-based *animations*, from a surface glance, can look similar to the interfaces (GUIs) of computer-based simulations. Looking at animations representing chaos systems for example, gives evidence that they are also based in simulation models. Additionally, there are options to vary parameters within the simulation model, which results in the modification of the dynamic pattern on a simulation’s interface. In respect to virtual laboratories, this we have already stated that the real equipment becomes represented by means of animations. Thus, there is no clear division-line between computer-based simulations and computer-based animations. We may define a distinction in respect to the stress that is given to the purpose to the underlying model. In case that it serves as a driver for an animation, we would not consider that to be a computer-based simulation. On the other hand, in cases that the animation represents features of the problem-space a user has to cope with, we would refer to that as a simulation. This however remains a weak point and is included in this line of argument for purposes of a more comprehensive view towards the field simulations.

The six approaches to computer-based simulations have in common the following two features: they allow the learner to explore decision-making outcomes; and, second, the problem solving space is free of risks for the learner and her or his environment. The results of errors may be experienced, but they are not associated with real costs. That way, options for action as well as hypotheses on the outcomes of measures taken can be tested, and hypothesis-based approaches for solving complex, dynamic problems can be encountered. *Errors* experienced by a learner can become a driving source for additional learning-activities (Kriz, 2001).

The distinctions given between the approaches to simulations only highlight the variability of the concept. A sharp differentiation cannot be achieved. Especially, with regard to business simulations and games, which becomes obvious because they include elements of role-playing and case studies (Capaul, 2001). Learners become assigned to a specific task as part of the role of a decision-maker or a problem-solver. Within a market simulation this, for example, may be the role of a marketing manager. This role of a manager has to be performed within a given scenario. Such a scenario can be considered to be the *case* of the simulation. In consequence, there has to be a close correspondence between the paper-based scenario and the model that is driving the simulation for the calculation of the future system statuses. Each new system status represents a variation of the starting scenario and gives cause for new learning activities to define new measures of action in order to modify a given less desirable system status into a more desirable one. This constitutes the dynamics of the simulation environment. The description given closely matches the concept of micro-worlds. These are learning environments, which aspects of a segment of reality are represented within a simulation model and which allow students to explore the environment including the model it is based upon (Edwards, 1995).

Due to the tradition of the case approach within the concept of simulations and games we will use this label within our follow-up argumentation. We'll stress the tactical-decision-making approach, because this is in large part based on a computer-based model of the represented environment. We will focus on the functions which simulations and games should have as part of learning environments and which specifics can be enhanced by means of web-based approaches. Again, we assume that the reader can transfer to the field of technical simulations and to related approaches.

Problem-Oriented Simulation Environments

Approaches to instructional design differ. They have developed over time and have stressed different perceptions of the learning process. Major effects on the discussions have come from the paradigmatic orientation within learning theories. Differences are due in large part to the cognitive shift in learning theories and, following that, to the constructivist view (Reimann-Rothmeier & Mandl 1996). This is not the place to elaborate on this development. Instead we follow two orientations. The first is to base our web-based simulations approach in an up-to-date orientation. The second is to refer to an orientation that is in accordance with the underlying assumptions, which have at least partly been addressed already in respect to learning activities, grounded in computer-based simulations and games.

We refer to the pragmatic approach published by the working-group around Heinz Mandl at Munich that takes up a mediating position between the constructivist and the preceding cognitive approach (Reinmann-Rothmeier & Mandl, 1999). This pragmatic approach provides room for teaching activities that support individual processes of knowledge construction.

One basic orientation for web-based simulations is that of a problem-oriented approach. Learning activities should be based in problems, which either are authentic in themselves or which at least refer to authentic problems situations, which are of relevance for the learner, which are based in present general or individual significance, and which evoke personal involvement. This orientation is based on the assumption that such problems result in four main effects:

- Lead to an active enquiry of the issue by the learner.
- Result in self-regulated learning activities.
- Evoke situated cognitions in the respect that inferences, solutions, points of view and interpretations are related to the problem situation.
- Allow for developing solutions by means of social interaction.

Behind these expectations, there is the concept of a learner that is predominantly active out of her or his own efforts and is receptive only for interim phases. The teaching environment in reverse should be able to switch between a mostly supportive and to a limited degree active performance. This position clearly objects to teaching approaches that favor unguided discovery activities on the one hand and externally directed learning activities on the other hand to avoid overstrain which can cause a decrease in motivation and hence lower learning outcomes. Problem-oriented learning activities are centered on five instructional design principles and corresponding objectives (Table 1).

The interpretation of this orientation in respect to learning with computer-based simulations is biased in favor of the simulation approach. There are, however, some rather obvious features to relate to at first glance. Simulation environments are set up for active explorations and interventions into the simulation model. They share the notion of active learners, who regulate their processes of orientation, learning, decision-making and/or problem solving.

Simulations represent a problem-space the learner can engage in. So, by definition, this is a problem-oriented approach. The degree of authenticity of the problem space will vary across context; this can be considered and planned for during the development of the simulation environment. This should be done in respect to the case(s) a simulation is grounded in and in respect to the features of the model(s) that drive the simulation. Given the multi-media features of contemporary computer systems, authenticity may also be supported by the inclusion of realistic and authentic images and video clips. Taking this approach would mean that there should be no simulations that merely represent a subject matter per se without providing for the opportunity to embed it into an authentic problem. This can also be considered as another claim for open designs, which allow for multiple uses of a simulation model. Realism also can be used in designing the GUI for a simulation. Students may look at features and information in a simulation as these can be *seen* in reality. A simple example may be the presentation of a gains and loss calculation on the financial status of a company. For that information, there is a professional format in business administration. Thinking for example of trainees in business administration to be a target group for a simulation, the information can be presented in the professional format. This is not only an issue of authenticity but can be considered also from the perspective of the ecological validity of the simulation system.

Multiple contexts can be offered by a variation of cases (scenarios) which simulations can be embedded. There is also the chance to have students actively relate from a simulation to their real (vocational or business) environment in respect to the structures and processes simulated.

Multiple perspectives are for the most part a defining feature of simulations based in their dynamics. For example, over time systems achieve different statuses of variables and thus have to be interpreted differently. This holds true for a single status representation. The level of a variable can or has to be read differently from different perspectives.

There is also an approach to this principle from having students' assigned to different activities in a simulation. In a single-user approach this can be accomplished by default parameter settings to a set of variables while the student is in charge of one specific variable. This provides a certain perspective on the system to the student, which will become different when she or he become in charge of another variable. In a multi-user approach this can be accomplished by assigning students to different activities and then having them rotate on these assignments in a sequence of simulation runs. Each change in assignments provides a different perspective toward the system and to the actions taken by the co-participants.

An example for the rather abstract statements above is available from early experiences in the field (Kummer, 1991): A team of three students was in charge of a simulated production company. The status of the system was represented on a printout. After having entered the group's decisions into the system one of the three students took a look at a new printout. He refers to the number zero giving the status for the finished product inventory. He explains to his teammates, "Zero is fine, because that way, there are no variable costs for the inventory." There are no objections against this statement from his teammates. The students study the printout for some more time and the second says, "There must be something wrong with the program because the figures say that demand from market was at 540 product units, while our sales have only been at 465 product units." Based on this finding the group calls the teacher and informs him about the bug in the program. The teacher screens the printout and replies, "You can solve your problem by means of looking at the figure zero in the finished product inventory.” The immediate reply from the first student is a hint to the variable costs being zero, concluding that the evaluation is fine. The teacher gives a positive feedback to this statement and insists that nevertheless the zero tells something in respect to the sales problem. In the meantime, the teacher was called away for assistance from another group. The three students are left with a possible problem. After some time the third student states, “He is right, we have no produce to deliver in our inventory and can not meet the demand from market that way.” The obvious finding is that information can be read from different perspectives and can represent different meanings from these perspectives; the fourth principle is highlighted by the example. Learning within social exchange processes confronts the students with different perceptions on a given situation. This too can be productive in generating new insights and in controlling idiosyncratic construction of knowledge.

The fifth principle, instructional support, is effective within simulation environments at a basic level as they are responsive to the decision-making processes of students. An input into the system generates an output. Students can figure out whether this output is reasonable and conclude from that on the appropriateness of their perception of the system. This is mirrored in the example above. This, however, does not yet include the performance of the teacher, who did not simply tell the right answer to the students, but restricted his support to a significant clue. For such performance a simulation-system would need a diagnostic component, which is not yet available. On that we will elaborate in the next section, taking into account the potentials of a web-based approach.

Diagnostic Web-based Business Simulations

The arguments presented thus far can be condensed into on overview toward what simulations and games can contribute to the problem-oriented learning and teaching approach. Table 2 represents essentials from the authors’ view, but does not claim to be comprehensive. In respect to most specifics of the web-based enhancements we cannot elaborate on all these within this chapter. We propose to make cross-references within this book for that. Instead the argumentation will turn to the specific issue of online diagnostic support for web-based simulations based on assumptions in respect to the computer infrastructure within educational environments. The web-based approach targets at providing computer-based simulations and games to a wider audience within the educational system or within training organizations. This orientation has to take into account the average infrastructure, which today is, and in the near future supposedly will be, given within such settings.

Schools, training institutes and training departments today have computer laboratories giving students and teachers access to computing resources. Such computer labs are linked to the web. Workstations are equipped with standard software products. Among these is a standard browser for navigating in the web. For installation of additional, specific software there are restrictions in respect to administrative privileges and to financial resources. Access to the Internet is via a technology, which is shared for all the workstations within a lab. This causes a bottleneck for data exchange. In addition there are firewalls and/or software installations for security against the hazards within the Internet. That way the user side of web-based simulations is to be considered a constrained environment with little options only for the use of sophisticated technology. This side should be served in a lean approach.

On the side of the provider, however, there are options for scaling the computer recourse needs. Computing power and speed for a server center can become available today with almost no restrictions. Different to the situation for the side of the many users this is a single need only. Restrictions on the server side again are in respect to security issues. The server needs control of access and defense against pirates in the Internet at the server side too. The conclusion from the technical perspective is, that requirements for the educational settings should be limited to the standard features available and that the process of data exchange should be designed for a lean and secure approach. Options for scaling the needs are on the side of the provider for web-based simulations and games. We will refer to this background in respect to three aspects of the design of web-based simulations:

- Design of a glass-box access to simulations.
- Implementation of a basis for online-diagnostics for simulation runs.
- Introduction of a process-perspective to the use of simulations.

The rational of a glass-box view on the model driving a simulation has been previously presented. In short, it is a method to provide the basis for the exploration of the complexity and the structural dynamics of the model. This can support the development of a holistic, systemic view toward the simulation, help for elaborations of the knowledge base, and support processes of meta-cognitive control. We approach that objective by means of the design of the GUI for a simulation game. The rationale is given in Figure 1.

The approach is grounded in the use of a system dynamics-based simulation model. Such models can be designed in a graphical format on the computer screen. A necessary requirement is the use of system-dynamics-based modeling software. The model can be developed in a graphical representation and can drive the corresponding simulation directly due to the underlying mathematical integration procedures (Berendes, 2002). We discussed this in the preceding section on web-based approaches to simulation within the paragraph on modeling. Recent research has come up with the finding that such models can be *read* by students and can foster the development of higher-level cognitive processes that cover a systemic view toward the simulation model (Hillen, 2004). On that basis, Molkenthin (2003) has developed a GUI-based approach for using the model within the Internet. There is a prototype-system running now at the Johannes-Gutenberg-University Mainz, which can be accessed, on request. Factually, the GUI is made up from a set of corresponding pages that become presented to the user with a standard browser after a login at the simulation server.

The basis for online-diagnostics in simulation runs is defined in the set-up of the simulation-server. Between the simulation-driver and the user there is a data bank server (see Figure 2). All communication from the simulation model to the user and vice versa becomes channeled through the data bank. This allows for keeping track of all exploratory actions a learner takes when working with the GUI. All decisions a learner enters into to the system become recorded before they are entered into the simulation model. Likewise, all information on the status of the simulation model becomes stored in the database. This covers essential information available on the use of a simulation, which can be collected within a run of the system.

The content of the data bank can be accessed in parallel to the simulation run and processed by a diagnostic routine in respect to structural information. This can refer to the patterns within the exploratory activities of a learner as basis for her or his decision-making process. An approach for the retrieval of such pattern is given within the works of Streufert and co-authors (Streufert & Satish, 1997; Breuer & Streufert 1995). The moves of the user within her or his exploratory activities can be displayed and mirrored back to the user (see Figure 3). This provides information for fostering self-reflection on the individual decision-making processes. In addition, a set of parameters can be calculated, which represent qualities within the processes. Examples here may be given by the breadth of the information search, which is applied, by the level of initiative a user takes or by the follow-through within the individual decision-making processes. Streufert and coauthors have defined such measures. They will have to be re-validated within the given context. Such process-related information can become available in addition to the standard system-status related information, which has always been given to the user since the early days of educational simulation uses. The interrelation between the two sets of information will be a focus for our future research efforts. The approach is considered to be an implementation of fourth generation measurement as defined by Bunderson, Inouye, and Olsen (1993).

In a medium perspective, the diagnostic information may become useful for instructional support to the learner. Feedback and feed-forward on decisions could as well be accomplished as the adaptation of simulation runs to the level of abilities individual learners can perform at. This however is an issue of research and developmental activities still to come.

Perspectives

Web-based simulations and games have been implemented in a variety of examples. They make use of features provided by technology. The application of principles of instructional design up to now does not seem to by a key issue in the field. This may in part result from the technical problems that have to be solved in the set-up of web-based simulations. The solution of such problems is essential. Beyond that there is the need for substantial foundation of the web-based approach in teaching/learning theory. The mere use of technical options can have an exploratory meaning. This however cannot be the level of professional developmental activities, which have to be grounded in principles of instructional systems design. We have outlined such an approach. Further we have tried to elaborate on the potentials that can be derived from that in respect to the implementation of diagnostic procedures, which can provide on-line information in respect to significant objectives of learning to the user. Following this line of argumentation, we can look at two major perspectives. The first refers to research on learning processes which make use of computer-based simulations and games. Diagnostic procedures can be used to collect information on such learning processes. Unlike *blind* tracing procedures from information technology, the approach defined has a direct link to information on the content within a simulation. Working with controlled groups under experimentally controlled conditions can provide new insights into learning and teaching processes. Such research can take place in the field, given the accessibility of core elements of the learning-environment via the web. This can include additional data collection in a web-based approach.

Our second perspective is defined within large-scale assessment of learning outcomes. Given the use of simulations in the diagnostics of managerial competences and for the measurement of problem-solving skills this could be extended to the diagnosis of competencies in the vocational respectively business administration field.

References

Alessi, S. (2000). Building versus using simulations. In J.M. Spector & T. M. Andersen (Eds.). *Integrated and holistic perspectives on learning, instruction and technology: Improving understanding in complex domains* (pp. 175-196). Dordrecht: Kluwer.

Berendes, K. (2002). *Lenkungskompetenz in komplexen ökonomischen Systemen*. Wiesbaden: Gabler.

Berendes, K., & Breuer, K. (1999) Potentiale von systemdynamisch basierten Mikrowelten. In G. Hohmann (Ed.) *Simulationstechnik* (pp. 113-116). Erlangen/Ghent: SCS Publishing House.

Bitzer, D., Sherwood, B.A., & Tenzar, P. (1972). *Computer based science education*. CERL-Report X-37.

Bork, A.M (1980). Physics in the Irvine Educational Technology Center. *Computers in Education*, *4*, 37-57.

Breuer, K (1983). Lernen mit computersimulierten komplexen dynamischen Systemen. In E. Lechner & J. Zielinski (Eds.). *Wirkungssysteme und Reformansätze in der Pädagogik* (pp. 341-351). Frankfurt: Peter Lang.

Breuer, K. (1985). Computer simulations and cognitive development. In K.A. Duncan & D. Harris (Eds.). *The proceedings of the world-conference on computers in education 1985 WCCE/85* (pp. 239-244). Amsterdam: North Holland.

Breuer, K., & Kummer, R. (1990). Cognitive effects from process learning with computer-based simulations. *Computers in Human Behavior*, *6*, 69-81.

Breuer, K., & Streufert, S. (1995). Strategic management simulations in the German case. In M. Mulder, W.J. Nijhoff, & R.O. Brinkerhoff (Eds.). *Corporate training for effective performance* (pp. 195-208). Norwell: Kluwer.

Bunderson, C.V., Inouye, D.K., & Olsen, J.B. (1993). The four generations of computerized educational neasurement. In R.L. Linn (Ed.). *Educational measurement* (pp. 367-407). Phoenix, AZ: Oryx Press.

Capaul, R. (2001). Didaktische und methodische Analyse der Planspielmethode. *Erziehungswissenschaft und Beruf, 1,* 3-14.

Doerner, D. (1996). *The logic of failure: Why things go wrong and what we can do to make them right* (1st English ed.). New York: Metropolitan Books.

Edwards, L.D. (1995). Microworlds as representations. In A.A. DiSessa, C. Hoyles, & R. Noss, (Eds.). *Computers and exploratory learning, computer and systems sciences* (pp. 127-154). Berlin: Springer.

Eyfert, (1974). *Computer im Unterricht*. Stuttgart: Klett.

Forrester, J.W. (1968). *Principles of systems*. Cambridge, MA: MIT Press.

Frensch, P.A., & Funke, J. (1995). *Complex problem solving. The European perspective*. Hillsdale, NJ: Erlbaum.

Frey, K (1995). *Die Projektmethode* (6th ed.). Weinheim, Germany: Beltz.

Gredler, M. E. (1992). *Designing and evaluating games and simulations. A process approach.* London: Kogan Page.

Haritz, J., & Breuer, K. (1995): Computersimulierte und dynamische Entscheidungssituationen als Element der multikulturellen Personalentwicklung. In J.M. Scholz (Ed.) *Internationales change-mangement* (pp. 109-120). Stuttgart: Schäffer-Poeschel.

Hillen, S. (2004). *Systemdynamische Modellbildung und Simulation im kaufmännischen Unterricht*. Frankfurt: Peter Lang.

Johnson-Laird, P.N. (1983). *Mental models. Towards a cognitive science of language. Inferences and consciousness*. Cambridge, MA: University Press.

Johnson-Laird, P.N. (1988). *The computer and the mind. An introduction to cognitive science*. Cambridge, MA: University Press.

de Jong, T. (1991). Learning and instruction with computer simulations. *Education & Computing*, *6*, 217-229.

Jonassen, D., & Tennyson, R. D. (Eds.) (1997). *Handbook of research on educational communications and technology*. Washington, DC: Association for Educational Communications and Technology.

Kriz, W.C. (2001). Die Planspielmethode als Lernumgebung. In H. Mandl, C. Keller, M. Reiserer, & B. Geier (Eds.). *Planspiele im Internet: Konzepte und Praxisbeispiele für den Einsatz in Aus- und Weiterbildung* (pp. 41-64). Bielefeld, Germany: Bertelsmann.

Kummer, R. (1991). *Computersimulationen in der Berufsschule – Entwicklung und Evaluation eines Konzepts zur Förderung kognitiver Komplexität im Politik- und Wirtschaftslehre-Unterricht*. Frankfurt: Peter Lang.

Merrill, M.D. (1997). Instructional transaction theory: An instructional design model based on knowledge objects. In R.D. Tennyson, F. Schott, N. Seel, & S. Dijkstra (Eds.) *Instructional design: International perspectives. Vol. 1: Theory and research* (pp. 381-394). Hillsdale, NJ: Erlbaum.

Miller, G.A., Galanter, E., & Pripram, K.H. (1960). *Plans and the structure of behaviour*. London: Holt, Rinehart & Winston.

Molkenthin, R. (2003). Zur Entwicklung einer systemdynamischen Unternehmenssimulation als Komponente von e-Learning. Unpublished master's thesis, Johannes Gutenberg-University, Mainz, Germany.

O'Neil, H.F. (1999). Perspectives on computer-based performance assessment of problem solving. *Computers in Human Behavior, 15*, 269-282.

Reimann-Rothmeier, G., & Mandl, H. (1996). Lernen auf der Basis des Konstruktivismus. Wie Lernen aktiver und anwendungsorientierter wird. *Computer und Unterricht, 23,* 41-44.

Reimann-Rothmeier, G., & Mandl, H. (1999). *Unterrichten und Lernumgebungen gestalten*. Göttingen: Hogrefe.

Renkl, A., Gruber, H., Mandl, H., & Hinkhofer, L. (1994). Hilft Wissen bei der Identifikation und Steuerung eines komplexen ökonomischen Systems? *Unterrichtswissenschaft, 22,* 195-202.

Schwarzer, C., & Buchwald, P. (2001). Beratung. In A. Krapp & B. Weidenmann (Eds.). *Pädagogische Psychologie* (4th ed.) (pp. 565-600). Weinheim, Germany: Beltz Psychologie.

Senge, P. (1990). *The fifth discipline*. New York: Doubleday.

Sterman, J.D. (2000). *Business dynamics. System thinking and modeling for a complex world.* Boston: McGraw-Hill.

Streufert, S., & Satish, U. (1997). Graphic representations of processing structure: The time-event matrix. *Journal of Applied Social Psychology. 27,* 2122-2131.

Tennyson, R. D. (2002). Linking learning theories to instructional design, *Educational Technology*, *42(3),* 51-55.

Tennyson, R. D., & Breuer, K. (2002). Improving problem solving and creativity through use of complex-dynamic simulations. *Computers in Human Behavior, 18*, 650-668.

Tennyson, R. D., & Foshay, W. R. (1998). Instructional systems development. In P. J. Dean & D. E. Ripley (Eds.), *Performance improvement interventions: Methods for organizational learning, Vol. 2* (pp. 64-106). Washington, DC: The International Society for Performance Improvement.

Wilbers, K. (2001). E-Learning didaktisch gestalten. In A. Hohenstein & K. Wilbers (Eds.). *Handbuch E-Learning: Expertenwissen aus Wissenschaft und Praxis.* Köln: Fachverlag Deutscher Wirtschaftsdienst.

Table 1

Principles and Objectives of Problem-Oriented Learning Activities

Principle of learning	Objective
Authentic problems in a situated orientation	Applicability of new knowledge
Multiple contexts	Usability of knowledge; reduced adherence of knowledge to specific situations
Multiple perspectives	Extended flexibility of knowledge
Social context	Reduced idiosyncrasies, social entrenchment and knowledge
Instructional support	Reduced risk of failure, efficiency and effectiveness

Table 2

Problem-oriented learning activities and online-simulations

Principle of learning	Simulations & Games	Web-based Enhancements
Authentic problems in a situated orientation	- Starting case(s), - Multimedia representation(s) - Glass-box (opaque) models	- Downloads for starting cases - Downloads for multimedia features - Model-based GUIs - Pop-ups - Flash animations
Multiple contexts	- Multiple scenarios - Variations of models	- Access to multiple scenarios - Access to varying models
Multiple perspectives	- Feedback on dynamics - Role-taking within different activities of a simulation	- Online feedback to dynamics - GUI-based representation of different activities - Role-taking within different activities - (Asynchronous; synchronous)
Social context	- Collaborative problem-solving	- Distributed collaboration (Asynchronous, synchronous)
Instructional support	- Interactivity (feedback on system-statuses) - Diagnostic features	- Online feedback to dynamics - Dedicated web-pages - Web-based discussion groups (asynchronous, synchronous) - Web-tutoring - Online-diagnostics

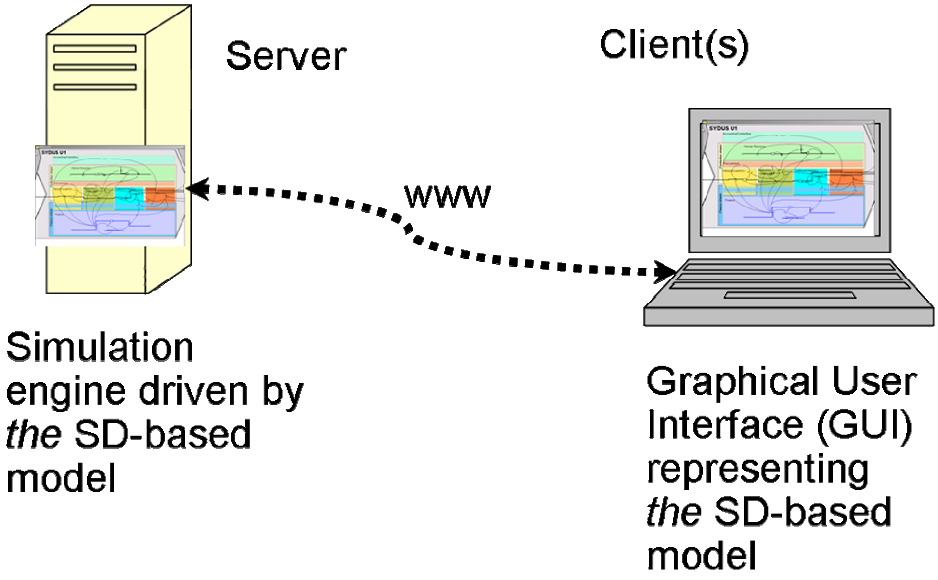

Figure 1: Glass-box model for the user.

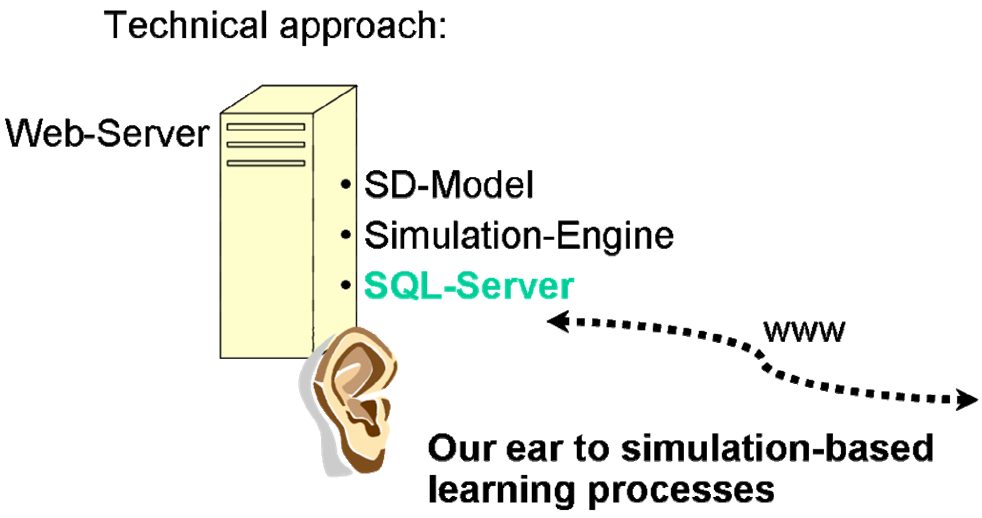

Figure 2: Diagnostics based on data bank-server.

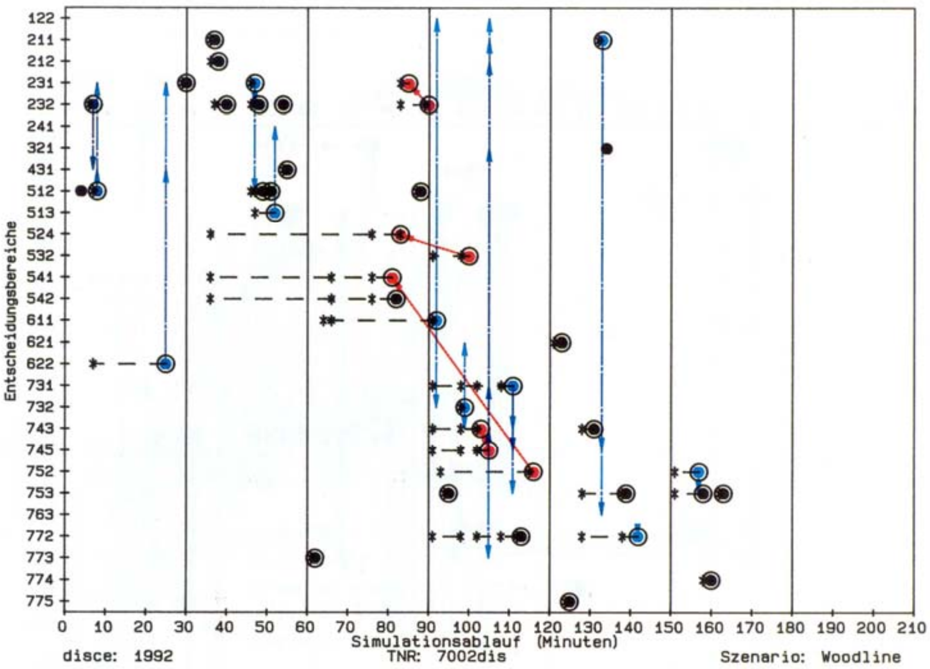

Figure 3: Time-event matrix from SMS to be adopted.

Bisher erschienen

Heft Nr. 1
Lüdecke-Plümer, S./ Zirkel, A./ Beck, K. (1997): *Vocational Training and Moral Judgement – Are There Gender-Specific Traits Among Apprentices in Commercial Business?*

Heft Nr. 2
Minnameier, G./ Heinrichs, K./ Parche-Kawik, K./ Beck, K. (1997): *Homogeneity of Moral Judgement? - Apprentices Solving Business Conflicts.*

Heft Nr. 3
Lüdecke-Plümer, S. (1997): *Bedingungen der Entwicklung des moralischen Urteils bei angehenden Versicherungskaufleuten.*

Heft Nr. 4
Heinrichs, K. (1997): *Die „Schlüsselqualifikation" moralische Urteilsfähigkeit – Ihre Entwicklung und Ausprägung bei kaufmännischen Auszubildenden.*

Heft Nr. 5
Beck, K. (1997): *The Segmentation of Moral Judgment of Adolescent Students in Germany – Findings and Problems.*

Heft Nr. 6
Heinrichs, K. (1997): *Betriebsbezogene moralische Urteile von Auszubildenden im Versicherungswesen – Persönlichkeitsspezifisch oder situationsspezifisch?*

Heft Nr. 7
Sczesny, Ch. (1997): *Das Lösungsverhalten bei wirtschaftskundlichen Aufgaben – Visuelle und physiologische Begleitprozesse situierter kognitiver Leistungen.*

Heft Nr. 8
Beck, K./ Bienengräber, Th./ Heinrichs, K./ Lang, B./ Lüdecke-Plümer, S./ Minnameier, G./ Parche-Kawik, K./ Zirkel, A. (1997): *Die moralische Urteils- und Handlungskompetenz von kaufmännischen Lehrlingen – Entwicklungsbedingungen und ihre pädagogische Gestaltung.*

Heft Nr. 9
Beck, K. (1997): *The Development of Moral Reasoning During Vocational Education.*

Heft Nr. 10
Sczesny, Ch./ Lüdecke-Plümer, S. (1998): *Ökonomische Bildung Jugendlicher auf dem Prüfstand: Diagnose und Defizite.*

Heft Nr. 11
Lüdecke-Plümer, S./ Sczesny, Ch. (1998): *Ökonomische Bildung im internationalen Vergleich.*

Heft Nr. 12
Beck, K./ Bienengräber T./ Parche-Kawik, K. (1998): *Entwicklungsbedingungen kaufmännischer Berufsmoral – Betrieb und Berufsschule als Sozialisationsmilieu für die Urteilskompetenz.*

Heft Nr. 13
Beck, K. (1998): *Wirtschaftserziehung und Moralerziehung – ein Widerspruch in sich? Zur Kritik der Kohlbergschen Moralentwicklungstheorie*.

Heft Nr. 14
Beck, K. (1998): *Moralerziehung in der Berufsausbildung?*

Heft Nr. 15
Beck, K. (1998): *Ethische Differenzierung als Grundlage, Aufgabe und Movens Lebenslangen Lernens.*

Heft Nr. 16
Parche-Kawik, K. (1998): *Wirtschaftsethik und Berufsmoral – Die Auseinandersetzung um das Leitbild für den modernen Kaufmann im Lichte empirischer Befunde.*

Heft Nr. 17
Hillen, S./ Berendes, K./ Breuer, K. (1998): *Systemdynamische Modellbildung als Werkzeug zur Visualisierung, Modellierung und Diagnose von Wissensstrukturen.*

Heft Nr. 18
Breuer, K./ Höhn, K. (1998): *Die Implementation eines Qualitätsförderungssystems für berufliche Abschlußprüfungen – Eine Interventionsstudie am Beispiel des neu geordneten Ausbildungsberufs Versicherungskaufmann/ Versicherungskauffrau.*

Heft Nr. 19
Beck, K. (1998): *Die Entwicklung moralischer Urteilskompetenz in der kaufmännischen Erstausbildung – Zur Analyse der Segmentierungshypothese.*
Minnameier, K. (1998): *Homogenität versus Heterogenität des moralischen Denkens – Wie urteilen Auszubildende im Rahmen betrieblicher Kontexte?*
Zirkel, A. (1998): *Kaufmännische Berufsausbildung und moralisches Denken – Erleben weibliche und männliche Auszubildende ihre soziale Umwelt unterschiedlich?*

Heft Nr. 20
Wuttke, E. (1999): *Lernstrategieeinsatz im Lernprozeß und dessen Einfluß auf den Lernerfolg.*

Heft Nr. 21
Beck, K. (1999): *Zur Lage der Lehr-Lern-Forschung - Defizite, Erfolge, Desiderate.*

Heft Nr. 22
Minnameier, G. (1999): *Wie man lernt, komplex zu denken, oder: Was substantielle Lernfortschritte sind und wie man sie erzielt.*

Heft Nr. 23
Beck, K. (1999): Fortschritt in der Erziehungswissenschaft? Anmerkungen zur Gegenwart einer unendlichen Geschichte.

Heft Nr. 24
Bienengräber, Th. (1999): *Die Entwicklung moralischer Urteilskompetenz im Betrieb – zur Bedeutsamkeit einzelner sozialer Bedingungen für die Genese der moralischen Urteilsfähigkeit.*

Heft Nr. 25
Parche-Kawik, K. (1999): *Wahrnehmung sozialer Interaktionsbedingungen am Arbeitsplatz – Unterschiede in den Sichtweisen von Auszubildenden und ihren Ausbildern.*

Heft Nr. 26
Beck, K. (2000): *Die Moral von Kaufleuten – Über Urteilsleistungen und deren Beeinflussung durch Berufsbildung.*

Heft Nr. 27
Bienengräber, Th. (2000): *Zur Frage der Bereichsspezifität in der Wirkung moralischer Entwicklungsbedingungen.*

Heft Nr. 28
Beck, K. (2000): *Alternative Research Approaches: Development Strategies in Educational Technology.*

Heft Nr. 29
Wuttke, E. (2000): *Cognitive, Emotional and Motivational Processes in an Open Learning Environment – How to improve Vocational Education.*

Heft Nr. 30
Beck, K. (2000): *Lehr-Lern-Forschung in der kaufmännischen Erstausbildung – Abschlußkolloquium eines DFG-Schwerpunktprogramms. Eröffnungsvortrag.*

Heft Nr. 31
Beck, K./ Dransfeld, A./ Minnameier, G./ Wuttke, E. (2000): *Autonomy in Heterogeneity? Development of Moral Judgement Behaviour During Business Education.*

Heft Nr. 32
Minnameier, G. (2000): *A New "Stairway to Moral Heaven"? Systematic Reconstruction of Stages of Moral Thinking Based on a Piagetian "Logic" of Cognitive Development.*

Heft Nr. 33
Beck, K./ Bienengräber, Th./ Mitulla, C./ Parche-Kawik, K. (2000): *Progression, Stagnation, Regression - Zur Entwicklung der moralischen Urteilskompetenz während der kaufmännischen Berufsausbildung.*

Heft Nr. 34
Beck, K. (2000): *Die moralische Dimension beruflicher Umweltbildung.*

Heft Nr. 35
Beck, K. (2000): *Abschlußbericht zum DFG-Schwerpunktprogramm "Lehr-Lern-Prozesse in der kaufmännischen Erstausbildung.*

Heft Nr. 36
Minnameier, G. (2001): *An Analysis of Kohlberg's „Stage 4 ½" within an Enhanced Framework of Moral Stages.*

Heft Nr. 37
Breuer, K./ Hillen, S./ Berendes, K. (2001): *Entwicklung und Elaboration Mentaler Modelle zu komplexen betriebswirtschaftlichen Erklärungsmustern über die computergestützte Modellbildung und Simualtion.*

Heft Nr. 38
Beck, K. (2001): *Moral atmosphere: Its components and its shape in vocational school and training company.*

Heft Nr. 39
Beck, K. (2002): *Erkenntnis und Erfahrung im Verhältnis zu Steuerung und Gestaltung - Berufsbildungsforschung im Rahmen der DFG-Forschungsförderung und der BLK-Modellversuchsprogramme.*

Heft Nr. 40
Minnameier, G. (2002): *Peirce-Suit of Truth - Why Inference to the Best Explanation and Abduction Are Not the Same and How This Relates to Current Debates in Philosophy of Science and Epistemology.*

Heft Nr. 41
Wuttke, E./ Beck, K. (2002): *Eingangsbedingungen von Studienanfängern – Die Prognostische Validität wirtschaftskundlichen Wissens für das Vordiplom bei Studierenden der Wirtschaftswissenschaften.*

Heft Nr. 42
Beck, K./ Parche-Kawik, K. (2003): *Das Mäntelchen im Wind? Zur Domänespezifität des moralischen Urteilens.*

Heft Nr. 43
Minnameier, G. (2003): *Wie verläuft die Kompetenzentwicklung – kontinuierlich oder diskontinuierlich?*

Heft Nr. 44
Beck, K. (2003): *Ethischer Universalismus als moralische Verunsicherung? Zur Diskussion um die Grundlegung der Moralerziehung.*

Heft Nr. 45
Wuttke, E./ Surać, V. (2003): *Der Zusammenhang von betrieblichen Interaktionsbedingungen und Facetten sozialer Kompetenz - Möglichkeiten der Diagnose.*

Heft Nr. 46
Minnameier, G. (2003): *Developmental Progress in Ancient Greek Ethics.*

Heft Nr. 47
Minnameier, G. (2003): *Measuring Moral Progress – Empirical evidence for a theory of moral reasoning.*

Heft Nr. 48
Beck, K. (2003): *Morals For Merchants – Desirable, Reasonable, Feasible?*