Reflections about Interactive Learning Environments: A Multi-Perspective Approach

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I. Abstract

An Interactive Learning Environment (ILE) is a tool to convey learning effects about dynamic and complex systems. Knowledge can be packaged and delivered to assigned persons. By this, several pedagogical objectives are achievable: Teaching the capability to operate dynamic systems, awareness about effective delays in the system, focusing on the importance of feedback loops and their strengths, and familiarize the learner with the concept of nonlinearities. As an instance, the flight simulator 'Managing a Consulting Company' puts each of two participant groups in the role of a consulting company's management board. The ILE is created as a network simulation, which facilitates a dynamic learning environment and enables greater learning effects than normal single simulation models. By experiencing and testing the simulation, the participants will obtain knowledge about the dynamic resource perspective of strategic management. In particular, the simulator provides learning effects about management of intangibles and dynamic decision making. In order to facilitate a successful ILE-training session, it is beneficial to reflect about several perspectives connected to the development of ILEs. This is the goal of the paper. It concludes with a heuristic about the different perspectives of an ILE-session.

Keywords: *Interactive Learning Environment, System Dynamics, Management Flight Simulator, Business Management, Reflection*

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1. Introduction

The topic of interactive learning environments (ILE) is not new. They have been extensively used in the fields of business management, but also in economics and in ecological management. The ILE provided in the paper focuses on the management of intangible assets. As exemplar, the management of a consulting firm in a competitive business environment was chosen. The basic idea about management of intangible assets does not depend on the subject; it is a general skill necessary in today's management world. The paper will use the example ILE to focus on different actor perspectives connected to an interactive learning environment session. It concludes with a heuristic about the different actor perspectives; each has to be accounted for in order to facilitate a successful learning session by means of interactive learning environments.

In Chapter 2, interactive learning environments in general will be described. First, possible definitions indicate that ILEs are used in several fields of research. Thereafter, famous and often used ILEs are described which use the method of System Dynamics. Chapter 3 concentrates on the four perspectives of an ILE: The System Dynamics model-, the facilitator-, the participant-, and finally, the ILE-perspective itself. Chapter 4 concludes with the creation of a heuristic about the four perspectives.

2. Interactive Learning Environments in General

Definition of An Interactive Learning Environment

What is an interactive learning environment? To define a term like this is a difficult adventure because the term is used in several scientific fields in different ways. Others even use different terms for the same concept (Morecroft 1988; Warren 1998). Some emphasize that an interactive learning environment is a web-based environment that supports structured interaction between communities of learners. Others see it as a computer simulation based approach to foster learning of groups or individuals. However, must an interactive learning environment be computer-based? Can a well created and designed board game not also be an interactive learning environment? One example for an ILE in form of a board game is Vester's Ecopolicy® (Vester 2002). Clearly, computer simulations provide unique features which board games cannot, e.g., the results of many runs can be stored and analyzed quickly, participants can be connected in remote locations via intra- or internet, and the possibility to embed multimedia applications.

Throughout the paper, the following definition of an ILE is employed: An ILE is a computer simulation, based on a model created with the System Dynamics Method and involves at least two human players as decision makers. The simulation model is about an issue of interest for the participants. The individuals' task is to perform successfully in a simulation characterized by distributed decision making. This definition includes the fact that at least two players are involved who influence each other by their decisions. Other authors do not include this criterion, e.g., Sterman considers a pure System Dynamics simulation model already an interactive learning environment (Sterman 2000).

Commonly Used Interactive Learning Environments

With respect to System Dynamics, several ILEs have been commonly used for teaching purposes. Almost every System Dynamics student knows the beer game, either as computer simulation (Goodman et al. 1993; Sterman and Fiddaman 1993) or as board game. The beer game is a simulation about the supply chain mechanism in the logistics business. The effects exhibited during the beer game simulation were and are explored in many research papers

(Anderson 2001; Duggan 2004; Machuca, Muchuca, and Maresca 1993; Milling 1999). The main phenomenon that emerges from the distributed decision making system with several interacting agents is the bullwhip effect. In other words, the system behavior exhibits strong overshoot tendencies due to the time delays in the system that are not accounted for by the participants.
Also the People Express Management Flight Simulator is an ILE for business management. The task is to successfully manage an airline by deciding about most important policy variables, such as number of offered routes, amount of airplanes and crew members (Sterman; Sterman 1988). Yet another famous ILE that focuses on the level of strategic management is Beefeater (Warren 1996). Here, the player has to manage a restaurant chain business. Another ILE is Strategem 2. It is a microcomputer simulation game in which the participants manage the economic development of a nation (Sterman and Meadows 1985a, 1985b). Another, and perhaps the most famous ILE created with System Dynamics, is the Fishbanks game developed by Meadows (Meadows 2000). Fishbanks simulates the fishing industry and their effects on the fish resources. Nearly every Fishbanks instance, with participants new to the subject of sustainable management, results in the total depletion of the available fish resources. The Fishbanks game has probably the high reputation because it is an impressive realization of Harden's tragedy of the commons (Harden 1968). But also other fields of science make use of ILEs for educational purposes. One famous exemplar is the game Ecopolicy® created by Vester (Vester 2002). The task in Ecopolicy® is to manage the development of a nation with the emphasis on ecology and sustainable management. To summarize, ILEs are commonly used for education purposes especially in the fields of business administration, economics, and ecology.

Purpose of An Interactive Learning Environment

Traditional approaches to business education have been increasingly criticized for having little relationship with what is important for succeeding in business (Pfeffer and Fong 2002). A method that connects the business education with the important knowledge and competencies in business practice is therefore required. One pedagogical approach is the problem-based learning method. It has a great potential for management education because placing students in a problem-centered environment may help bridge the gap between theory and practice. (Sherwood 2004). Problem-based learning owes much of its development to the medical fields. Although schools of management, law, and other disciplines have approaches that fall under the problem-based learning umbrella, the medical profession has taken a leading role in research and curricular application (Sherwood 2004). System Dynamics oriented publications dedicated to learning report of consulting approaches that facilitate client's learning and of management simulators as vehicles for learning (Morecroft and Sterman 1994). The purpose of an interactive learning environment is therefore to provide learning effects from the interaction with simulators (Christensen et al. 2000; Doyle and Ford 1998). It may be important to distinguish between learning from modeling and learning from the interaction with finished models (Forrester 1985; Maier and Größler 2000). The standard believe for ILEs is that the client interacts with a standard management simulator like the beer game or beef-eater simulation and learns about the modeled and relatively generic system. It is noteworthy that only some research into learning effects has focused on different modes of interacting with finished models, i.e., interaction with standard models by simulating or building the models from scratch and interacts with the model as second step.

For this report, I chose to determine the purpose of an ILE more practical in order to easy a discussion of the success of an interactive learning environment session. It is apparent that by means of an interactive learning environment, knowledge can be packaged and delivered to persons in demand (Davidsen 2000). However, an ILE should not only transmit theoretical

knowledge like literature does; it should convey the knowledge more easily accessible and comprehendible to the persons in need (Follows 1999). Hence, an ILE which shall enable a deeper understanding of complex systems must achieve at least the four pedagogical objectives:

- Teach the capability to operate dynamic and complex systems,
- Increase the learner's awareness of the effective delays of the system,
- Point to the importance of feedback loops and their strengths, and
- Familiarize the learner with the concept of nonlinearities.

In order to achieve the mentioned objectives, two conditions have to be met: 1. transparency of the system structure, and 2. reduction of natural data overload. Davidsen points out that an ILE should not only exhibit the behavior of the system at hand, but also reveal the underlying structure, as well as the relationship between structure and behavior (Davidsen 2000). As for the second condition, it is necessary to concentrate only on the most important features of the modeled system in order to foster comprehension of the system. Both conditions are be fulfilled by the simulation method System Dynamics.

3. The Different Perspectives of an Interactive Learning Environment Session

An interactive learning environment, as defined in the previous chapter, is a computer simulation based on a System Dynamics model and involves at least two human players as decision makers. By this definition, the object 'interactive learning environment' can be analyzed from at least three perspectives: The perspective of the System Dynamics modeler, the perspective of the participants, and the perspective of the facilitator. In the following, these three perspectives will be elaborated on the basis of the case example of a management simulator. Figure 1 represents the relationships between the aforementioned perspectives.

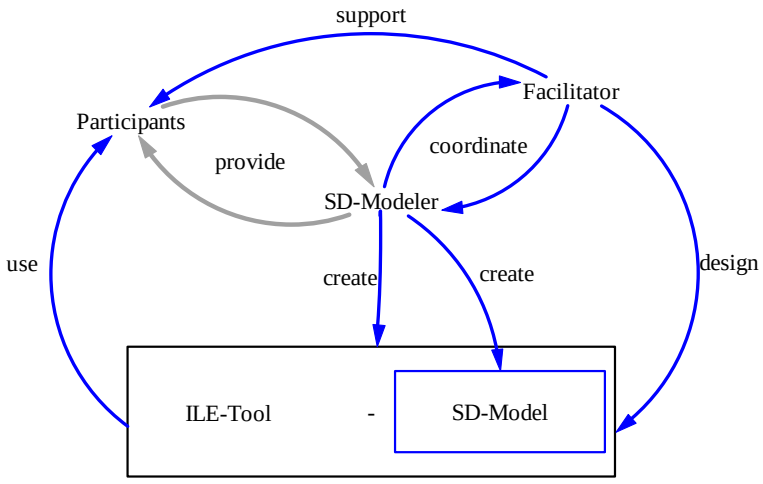

Figure 1: Important Perspectives of An Interactive Learning Environment Session

A central position has the System Dynamics modeler. As Figure 1 reveals, the modeler has the most relations to the other constituents. That is, the modeler creates both the SD-model and the ILE-Tool. The creation process is coordinated with the facilitator in order to ensure the usefulness of the System Dynamics model for an ILE session. It is possible that the SD-modeler has a direct contact to the participants, e.g., when the created model and ILE is adapted to a certain company situation or context. A further influence the facilitator has is on

the design of the ILE-Tool, especially the advice for the creation of the interfaces. He ensures that the design of the interfaces is according to learning psychology standards in order to ease learning for the participants. Moreover, the facilitator supports the participants to benefit from the ILE session to the largest possible extend. This support or transformation function of the facilitator is considered the most important with respect to the learning effects of the participants. And finally, the participants make use of the ILE-tool to learn about the modeled system.

3.1 The Perspective of the System Dynamics Modeler

3.1.1 The System Dynamics Model

The first perspective is the one of the System Dynamics modeler. First, it covers the aspects of the System Dynamics model formulation that are familiar to most System Dynamics modelers, e.g., determination of the purpose of the model, crucial variables, feedback loops, simulation runs and simulated model behavior (Sterman 2000). And second, the creation of the ILE-tool with the belonging attributes. For the chosen example, most of these aspects will be elaborated below.

Purpose of the Management Flight Simulator

The created example management simulation 'Managing a Consulting Company' is about the management of intangible assets, which are essential for the success of a consulting firm. Opposed to the management of industry businesses, which deals basically with tangible and manifest objects, the management of a consulting company is, like any other service oriented businesses, about management of soft factors and intangibles. Considering the current business development towards the service oriented business sector, the so-called tertiary sector, managers of the future have to refocus their attention on invisible and vague attributes of subjects and objects (Groesser 2005). The purpose of the management flight simulator 'Managing a Consulting Company' is to capture important soft variables and reveal the mechanisms between intangible assets, company success and company value, respectively, in the service industry. These mechanisms and relationships are especially considered and explored in the resource based theory of the firm in strategic management research (Penrose 1959; Rubin 1973; Teece 1982). The simulation starts in the year 2005 and lasts for 10 years. This time horizon is selected in order to show the results of the decision taken when delays are active in the system.

Model Boundary Chart

The model boundary chart distinguishes between three kinds of variables: Endogenous variables, exogenous variables, and variables not considered. Since the purpose of the simulation model is to train employees of a consulting firm about the mechanisms of intangible assets, the model concentrates on relevant factors from a practical point of view. These factors are: Number of employees, service capacity, service quality, employees' satisfaction, customers and customers' satisfaction, and the financial success of the company. Another factor is the competition between companies offering the same product on the same market, in other words, competing in the market place for customers. Other markets, such as labor or financial markets, are not considered. The aforementioned variables are modeled as endogenous variables. Exogenous variables are parameter values and are not influenceable, e.g., total quantity of customers, the hiring and layoff time and costs for further education. Variables that are not relevant to achieve the purpose of the model are not considered, e.g., inflation, financial accruals, labor piracy. Figure 2 provides a chart about the model boundary selection.

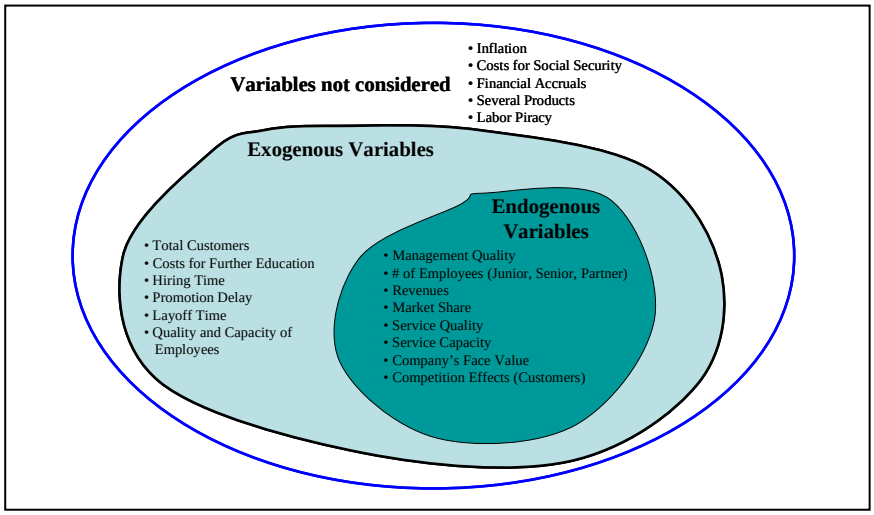

Figure 2: Model Boundary Chart

Subsystem Diagram

The subsystem diagram in Figure 3 represents the connections between the four subsystems of the System Dynamics model: Finances, employees, processes and customers. The four subsystems represent the four perspectives of the known Balanced Scorecard (Kaplan and Norton 1996a; Kaplan and Norton 1996b). The Balanced Scorecard reaches beyond standard financial measures and includes customers, employees and internal processes and is, therefore, more adequate to serve as holistic management framework in the business environment. This is why it is chosen as basis for the ILE.

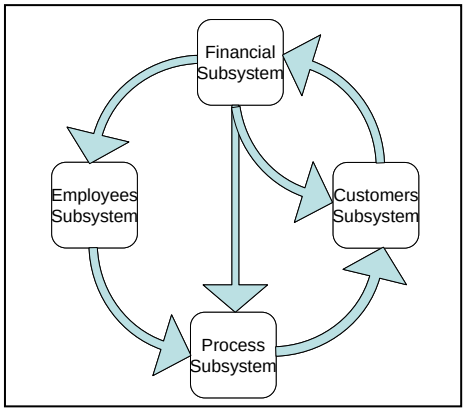

Figure 3: Subsystem Diagram of the Simulation Model

Causal Loop Diagram

The causal loop diagram, shown in Figure 4, carves out important feedback mechanisms in the model about the management of intangible assets. The polarity of all of the loops but one is positive indicating a strong reinforcing system. However, the negative loop exhibits a powerful balancing tendency since it includes the limited resource phenomenon, in the case of the management simulator the costs associated with the activities undertaken. The link and loop strengths depend on the participants' decisions. The variables 'participant's evaluation x' (with x = {A, B, C, D}) represent the decisions by the participant. By assigning values to the decision variables, the participants simultaneously determine the strengths of the different loops. In other words, a general assertion about the polarity of each loop can be made. The strength, however, of each loop cannot be determined in advance because it depends on the participants' decisions, for instance, in situation S1 participant P1 decides to boost the employee training and spends more financial resources on this possibility. In the same situation S1, however, participant P2 decides that marketing activities can better help to foster

the beneficial development of the company. This example shows that there are multiple reactions possible to the same environmental situation. A description of the feedback loops is not provided since the purpose of the paper is to discuss the object 'interactive learning environment' and not a particular ILE or model in concluding details.

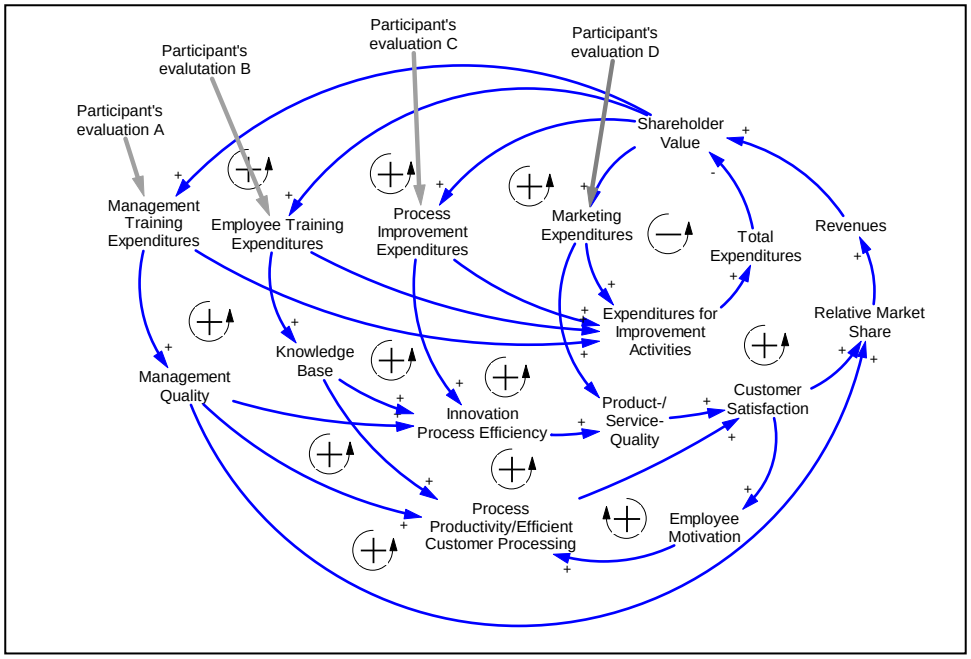

Figure 4: Causal Loop Diagram

3.1.2 The Interactive Learning Environment Tool

The second task of the System Dynamics modeler, besides the creation of the System Dynamics model, is to create the ILE tool. The required steps for this task will be explained by means of the example management simulator.

The Purpose of the Example Interactive Learning Environment

Providing vividness is the essence of leadership. In an often turbulent world, leaders need tools to help them achieve this vividness (Ritchie-Dunham and Rabbino 2001). Interactive Learning Environments enables individuals to interact with an artificial, but reality oriented, simulation program. Well developed ILEs facilitate the development of more sophisticated mental models, focus conversations among executive teams, and, as a result, facilitate more effective problem solving. The participants have the opportunity to learn about the management of intangible assets. The objective for the described ILE is to foster managers' capabilities to manage firm's success by controlling company's intangible assets in a dynamic and competitive environment.

Technical Specifications of the Interactive Learning Environment

The interactive learning environment is realized as symmetric game. All participants have the same positions in the market and have, by definition, the same tasks. The programming language is Powersim Studio 2005. It is chosen due to the rich possibilities of graphical elements for the design of attracting simulation interfaces. The ILE provides besides the simulation model, a debriefing model (Figure 5). The simulation model (microworld) is designed as a two player simulation. However, in absence of a second participant, the simulation comes with the functionality to change to a single player mode, thus, enabling single player learning effects.

The Structure of the Interactive Learning Environment

The simulator consists of three parts: the microworld, the information system and the simulator controls. The microworld represents the structure of a single consulting company, including organizational capabilities, service capacity acquisition, the financial system, the market and customer base as well as competition. The microworld consists of a model of each of these components, and will generate dynamics over time as decisions are made. The information system reports the current state of the system and allows reviewing the history of the firm in detail. The information can be used by the participant to make strategic and operational decisions. The microworld is the core of the simulator and has been tested and calibrated extensively. It is as every model a simplification of reality (Sterman 2002). Important factors for managing an, by organization capability driven, consulting company are considered. The simulator contains an information system based on the Balanced Scorecard Theory (Kaplan R. S. and P. 1996; Kaplan and Norton 1996b), which allows monitoring developments in the areas of the firm and market. In each round, the participant has access to reports about the current status of the market, the financial, the personnel and the business process situation. The information system provides enormous information among which the participant has to decide. The Balanced Scorecard approach is chosen because the four standard dimensions (financial, market, internal resources, and customers, cf. also Figure 3) best categories the dependent and independent variables and of the simulator. During the simulation, the Balanced Scorecard represents the numerical variables. By clicking on them, their interconnection in with other variables of the simulation model will be exhibited by means of a simplified stock- and flow-diagram.

The simulation is controlled by several 'Simulator Controls'. For each quarter, the participant has the opportunity to execute several decisions, which can be grouped into three complexes: Financial allocation, personnel management, and price policy (cf. Table 2). Figure 5 sketches the hardware structure of the ILE. On the first level, the System Dynamics model, the information system based on the Balanced Scorecard and the management decision panel are connected with each other. The arrows indicate exchange of data between the elements. Number 1 and 2 stands for the player group. The second level, named as 'Excel-Based Data Transfer' is the storage space for the decision variables. The last level 'Debriefing Simulation' is not directly attached to the System Dynamics model. The 'Debriefing Simulation' is a slimmed version of the simulation model and uses the variable values saved in the Excel-based data-file.

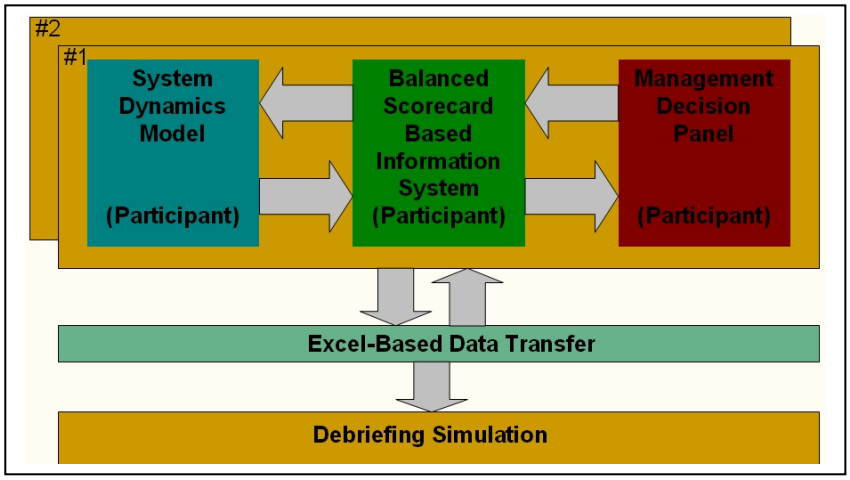

Figure 5: Structural Organisation and Flows between the Single Models

Limitations and Shortcomings of the Interactive Learning Environment

Several shortcomings exist in the current version of the interactive learning environment. First, the simulation model is designed for two players. By utilizing an additional information file and small changes of the setup, it is possible to use the ILE as a single player version. More labor-intensive is the change of the design to include more then two players because the exchange protocols have to be rewritten and the connections have to be checked to ensure correct results. The adoption of the simulation model itself is done in seconds.

Another shortcoming, with respect to the content of the ILE, is the assumption that cooperation and collaboration between companies does not exist and inter-partner learning effects will not occur. This assumption is far from reality. A further step is to include theories about inter-partner learning effect provided by literature about strategy management (Hamel 1991). A second limitation regarding content of the ILE is that both companies compete on the same market and have the same product. In addition, that both competitors enter the market simultaneously with the same start conditions. Obviously, these assumptions are artificial but were chosen to enable equality among the participants and comparability of the results and learning effects.

The Interface of the Interactive Learning Environment

The interface of the ILE is designed in Powersim Studio 2005. During the design phase of the simulation and the interface, the help of a psychologist was used to design attracting and beneficial interfaces but simultaneously avoiding the information overflow phenomenon. Figure 6 shows the interface of the debriefing environment.

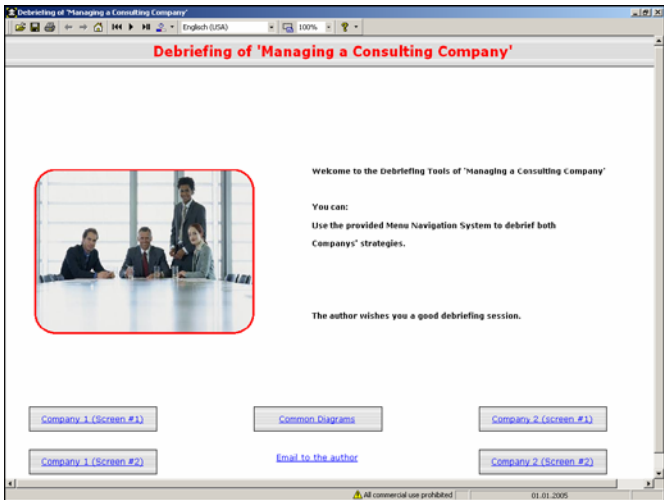

Figure 6: The Welcome Screen of the Debriefing Program as An Interface Example

3.2 The Perspective of the Participants

As pointed out in Figure 1, the participants have three interactions in the ILE-setting: interaction with the facilitator, usage of the ILE-tool, and if planed, the elaboration of the ILE and System Dynamics model with the modeler. The participants are the decision makers in a virtual consulting company. The facilitator provides as much information about the company as the participants want. Ideally, the ILE is customized to the company for which the project is performed, in this case for a consulting company. The simulation and the important tasks of the participants are explained by the facilitator. In the original documentation of the ILE, a comprehensive description about the situation of the participant and the firm is provided in a psychological pleasing manner. Table 1 provides an example of the first introductory sentences.

> Congratulations! You have just been hired to manage a mid-sized consulting company in your country. Together with the other players in your company's managing board, you will execute several decisions each quarter according to policies you design to maximize our value of the company. Please read the following information attentive…

Table 1: Introduction of the Original Document of Participants Documentation

The first task for the participants is to form a group of several people and assign the positions of a normal management board to the participants, e.g., CEO, CFO, and COO. For the management simulation, two management board teams are required. The group size depends on the total number of participants and on the facilitator's decision if some firms should be substituted by the computer: so-called predefined, or ex-ante agents. In the following, the decision variables for the participants and the success criterion are explained to get an impression about the tasks of the participants during an ILE-session.

Decision Variables for the Participants

It is essential for the participant to know the provided manual in detail in order to reduce required time due to technical questions. Table 2 shows all decision variables of the simulation model. They will be explained in more detail.

Decision Field	Decision Variable	Variable Name in the Model	Minimum Value	Maximum Value
Financial Allocation	Marketing Expenditures	ME	0.00	100.00
	Business Process Improvement Expenditures	PIE	0.00	100.00
	Employee Training Expenditures	ETE	0.00	100.00
	Management Training Expenditures	MTE	0.00	100.00
Personnel Management	Junior Consultant Hiring	Junior Consultant Hiring	0	Unlimited
	Junior Consultant Layoff	Junior Consultant Layoff	0	Employed Junior Consultants
	Senior Consultant Hiring	Senior Consultant Hiring	0	Unlimited
	Senior Consultant Layoff	Senior Consultant Layoff	0	Employed Senior Consultants
	Partner Hiring	Partner Hiring	0	Unlimited
	Partner Layoff	Partner Layoff	0	Employed Partners
Price Policy	Price	Price	0.00	Unlimited

Table 2: Overview over Decision Variables and Feasible Values (Groesser 2005)

Marketing Expenditures

Marketing describes the role of advertisement in stimulating demand. What fraction of revenues will be allocated for marketing? The participant will set the marketing budget by allocating a fraction of revenues to the marketing function. For example, the participant may decide that each year he wants to spend 0.07 (7%) of revenues on marketing.

Business Process Improvement Expenditures

What percentage of revenues will be allocated for business process improvement? For example, the participant may decide that each quarter he will spend 0.03 (3%) of revenues on external consulting services. Analysis puts forth, that the business process improvement expenditures improves the internal processes and, thus, the service quality.

Employee Training Expenditures
Employee training expenditures are a fraction of the revenues. By employee training, the knowledge base available in the company can be increased.

Management Training Expenditures
Spending for management training expenditures is a fraction of revenues. By management training expenditures the quality management can be improved. The spending is used to purchase external personnel consulting companies to perform management training in seminars.

Hirings and Layoffs
How many junior consultants are needed to satisfy the market demand in consulting services? What service capacity is necessary? How many senior consultants and partners are needed? Senior consultant and partner do not contribute the same quantity to the service capacity, because they are also occupied with managing the consulting company and with acquiring new customers, respectively.

Price
What price will the participant charge for his service? Each quarter he must set the price for the service. He will probably wish to consider employment costs, desired profit margin, competitor price and the supply/demand balance as he sets his price. The participant may also wish to use price as a competitive weapon to achieve the goals for long-term market share and profitability, and to deter or counter the strategy of his competitor.

Bank Account
The bank account is increased by revenues from consulting service sales, and decreased by expenditures for personnel payment, for marketing-, training-, and business process improvement expenditures. The price is subject to the participant's decision each month.

Criterion for Success
The goal of the management board is to achieve the greatest possible company value by the end of the game. The company value is calculated by the monthly profits and several intangible assets, such as knowledge base, customers and management capabilities. Table 3 shows value drivers which can be influenced and which are important for the company's success. The weight needs to be adapted to the specific industry in order to represent a motivational situation that is similar to the real life situation of the participants.

Variables	Weight
Customers	100
Management Quality	1000
Service Quality	1000
Knowledge Base	1000
Free Cash Flow	100

Table 3: Set of Variables for the Calculation of the Company Value

3.3 The Perspective of the Facilitator

Facilitator's Tasks Defined as Process

The facilitator of an interactive learning environment session has a critical task with regards to the learning success the participants can gain. It is simply not enough to create a sound simulation model and hand it over to the customers or participant respectively. A reviewer of the article phrased it with the following words: "What we need is a way to spread the learning not a discussion about the ins and outs of the particular model."[2] This and the lack of literature about facilitating ILE-sessions indicate that more research is needed in this direction. The aforementioned problem-based learning method, a pedagogical approach, seems to be promising and fruitful. This approach emphasizes the context conditions of learning situations, as can be seen in the following citation.

> "Those authentic contexts are vital to the many fields that require specific professional training. That, of course, is a dramatic shift from the traditional view of cognitive development resulting from one's reception of knowledge transmitted by the instructor. Problem-based learning holds promise as a teaching tool that provides for the acquisition of problem-solving skills to meet the challenges of the twenty first century workplace" (p.5) (Edens 2000).

Interactive learning environments are an excellent tool to facilitate the described problem-based learning. Barrows points out that there are at least two antecedents to the probability of accomplishing these learning objectives and executing this process. One is the locus of control of learning. The other is the nature of the case (Barrows 1986). Figure 7 depicts the two dimensions. An ILE facilitator has to decide which approach to take according to the participants' demands and the strived objectives.

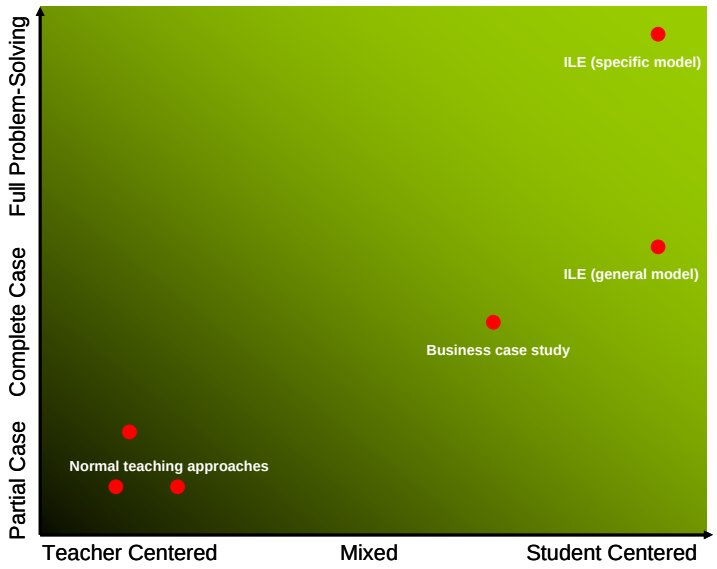

Figure 7: The Creation of a Learning Environment Depends on Two Dimensions

After having decided about the nature and the context of the interactive learning environment, the tasks of the facilitator during the realization process of the interactive learning session can be distinguished in six steps (cf. Figure 8). As can be seen, the time effort required to complete the single tasks decreases alongside the process.

[2] Special thanks to one reviewer for this valuable assertion.

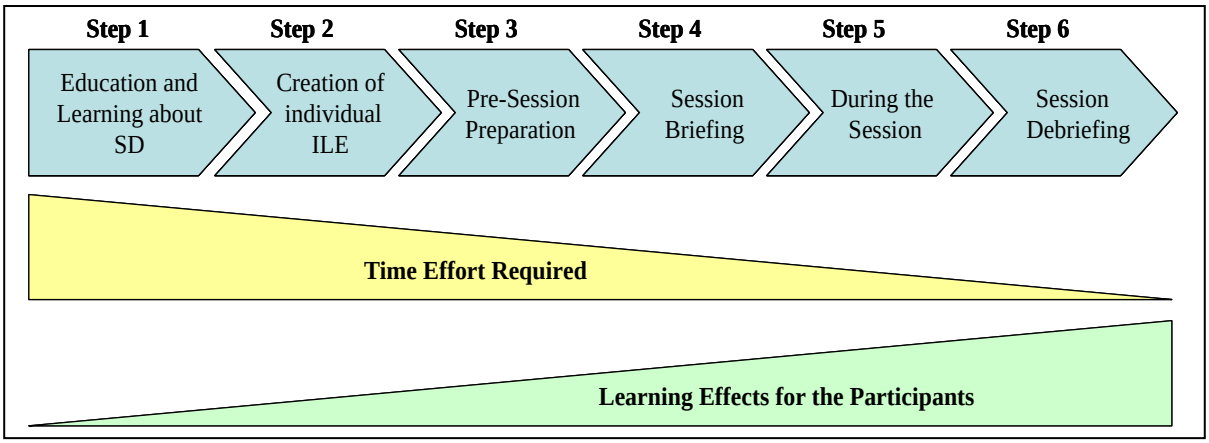

Figure 8: The Process of the Interactive Learning Session for the Facilitator

Step 1 and Step 2
Especially step one and two are time consuming, but however necessary for the successful creation of an ILE. The learning effect of the participants is considered to be reciprocal to the time effort required by the facilitator. Step one and two will not be explained in detail since they are normally subject of semester courses in modeling at universities. The Chapters 3.1 and 3.2 contain the basics about the creation process of the simulation model. In the following, the single steps from Step 3 until Step 6 will be explained in more detail.

Step 3.1: Facilitator Guidelines for Pre-Session Preparation
The pre-session preparations comprise the computer installations on site. The following tasks have to be executed to set up the interactive learning environment:

- Start the simulation software
- Open the flight simulator

Step 3.2: Software Required
This version of the flight simulator is designed as a two player, symmetric network game. To play the simulation, two Desktop PCs or Laptops (in the following: client), adequate common server space (in the following: server), network connections, the Microsoft Office Programs 'Excel 2003' and 'Word 2003', Powersim Studio 2005, and access to the internet are required.

Step 3.3: Set up the Simulation Files and the Network Game
The simulation files have to be copied to the Desktop area of the first client. The same process has to be repeated for the second client. Thirdly, the facilitator must copy the Microsoft Excel files to the common server area, e.g. the System Dynamics network drive. Groesser describes the instructions in more detail (Groesser 2005).

Step 4: Briefing of the Participants
The briefing is a necessary process to introduce the participants to the environment and to the purpose of the simulation session. The briefing material for the example is included in the simulation file. The participants can access all information about the model structure. In order to understand the stock and flow representations, basic knowledge in System Dynamics is needed.[3] Because the briefing material is provided with the simulation program, no extended

[3] The participants can always during the simulation access the internet pages of the System Dynamics Society, especially the Introduction to System Dynamics. Thereby, the participants can learn basic concepts of System Dynamics by using online material. (http://www.systemdynamics.org/DL-IntroSysDyn/index.html).

general briefing is necessary. However, the facilitator shall introduce the participants to each other, talk about the purpose of the managing simulation, the history of the simulation, create teams and show the navigation possibilities and menu structures. If the players have not been exposed to simulations before, they may be skeptical about their value. The introduction must point out the relevance of the simulation session and convey a sense of enthusiasm, challenge, and importance. Moreover, the facilitator should announce a time period of at least two hours for the first round. During this first round the players should get familiar with the simulator and the main concepts of System Dynamics.

Step 5: Tasks for the Facilitator during the Simulation
During the simulation, the task of the facilitator is to ensure that the simulation runs without any interruptions. He should be particularly alerted for players who appear to be confused or disinterested. The facilitator should seek them out and draw them back into the game. One possibility is to ask players why they are making the decisions the way they did. It is possible to suggest several options in a neutral way. The facilitator has to ensure that each group discusses the topics, but that there should be no interaction between the groups.

Step 6: Simulation Debriefing
To realize the full potential of the flight simulation, it is essential to discuss the simulation and the results thoroughly at the end of simulation. The precise strategy for the debriefing naturally depends on the objectives of the facilitator and the demands of the participants. The ILE can serve many different purposes, such as:

- Comprehend basic concepts of System Dynamics,
- Illustrate the problems associated with control of complex and nonlinear systems,
- Offer participants an opportunity to practice group communication and leadership skills,
- Gain understanding of time delays in a complex system, and
- Feeling the effects of counter-intuitive behavior of dynamic systems.

According to Meadows et al., the debriefing process proceeds through the following seven stages (Meadows, Fiddaman, and Shannon 1993):

- Convey important principles about the intangibility of knowledge and capabilities,
- Determine the extent to which those also occur in the real system,
- Decide what factors in the game were responsible for the problems and events,
- Determine the extent to which those factors are also present in the real system,
- Figure out changes in the simulation that would avoid or solve the most serious problems,
- Indicate the corresponding changes that could be made in the real system, and
- Gain commitment from the players that they will seek to achieve the necessary changes in the real system.

Objectives of the Facilitator
Given the facilitator is an external consultant, its objective is to achieve the clients purpose with the interactive learning environment which can vary between, e.g., team development effects, education in system thinking, learning about system dynamics, to reflect about their everyday problems from a more holistic perspective. Especially important to achieve the client's objectives, simulation debriefing is most essential. The debriefing is the step during which the participants gain the most insights into the system under study (Figure 8), e.g., how actors in other departments act according to several external factors.

4. Conclusion

The paper has elaborated that at least three different perspectives of an ILE exist. Figure 1 shows the integration of all three perspectives in a heuristics. Remarkably is that the perspective of the System Dynamics model, in other words, the SD-modeler who creates the simulation, has an crucial position compared with the other two perspectives 'Participant' and 'Facilitator'. This indicates that the perspective of the SD-modeler has to be wider, thus, containing issues that are important for the model creation process, e.g., about the learning effects the system offers, how to represent them, to evaluate if the participants find this worth learning. Also the facilitator's role, to create a problem-based learning environment, is one of importance to achieve the objectives of the ILE-sessions: to help the participants to learn about dynamic and complex systems. To conclude, the creation of an interactive learning environment is a challenge which needs a thorough understanding about the system, the participants, possible learning effects, and how to capture the dynamics in a System Dynamics model. It is worthwhile to focus on the tasks of the facilitator in the whole ILE-process because he has as a kind of overall manager to ensure the success of the ILE-session. Up to now, the System Dynamics community has not accounted the insights created by the science of pedagogy and detailed the tasks of the facilitator of an ILE-session. In the Group-Model Building thread, this connection has already been established. For the interactive learning environment thread, an incorporation of the problem-based learning method appears worth pursuing.

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