CUSTOMIZATION OF INDUSTRIAL TRAINING
Benefits and Problems

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Abstract: The main focus of this paper describes how authenticity can be applied to computer-based learning environments through customization. We argue for using learning tools, which not only provide realistic and complex models of reality, but are also authentic, facilitate continuous problem solving and meaningful learning, and embed learning in social experience. We describe a continuously processed business simulation game, which differs from the majority of business games in the way it is processed. Two company in-house training sessions are then described. In these sessions the learning environment was customized to describe the real-world environment of the case company. We conclude that customization of a business learning environment increases the learners' motivation and meaningful experiences. Furthermore, customization includes potential in facilitating transfer of learned knowledge and skills to a real world working environment.

Key words: Industrial Training, customized learning environments, business training.

1 INTRODUCTION

Realgame (the argumentation behind *Realgame* is presented in Lainema 2004a and 2004b) is a computer-based simulation game, which creates a complex and authentic-like environment for learning business studies. *Realgame* models the environment of up to 8 manufacturing companies that compete against each other in a virtual computer network environment. Each participating company consists of optimally three participants. The company decision-making application (used by a student group) includes the main decision-making functions of a manufacturing company.

Traditionally, business games have been batch-processed. The game participants create plans for their companies for a certain period (typically a few months or a year). These plans are then entered to the simulation model. The simulation model calculates the results from the plans and generates a historic report. Thus, the simulation model is a black box within which the game participants have no internal view. The decisions and the results from them have no explicit cause-relationship as the black-box structure of the simulation prevents any direct interaction with the simulation processes. In this process there is no guarantee that the learner creates a valid presentation of the cause-relationships.

Realgame, however, is operated in real-time – continuously. *Realgame* includes a clock-driven market engine on the server of a computer network, creating demand and supply. The groups constantly exchange information with the market server over the network. This interactivity brings along some advantages not met in batch-processed games. Decision-making and feedback from the decisions takes place in an interactive on-line mode. Decisions are made as soon as they are needed or at least as soon as the decision-maker notices that the situation needs actions from them. This is radically different from traditional business gaming which presents a static view of business operations at a specific time between game periods and where decisions can be entered only when the simulation is halted.

Continuous processing means that the game clock and game events keep on taking place continuously when the game clock is turned on. This resembles, e.g., modern production management information systems. In *Realgame* the game market application triggers the game internal clock in one-hour cycles and the participant game applications follow the market time. The participants see the game clock (hour, day, and month) on their computer screens. One game hour may take from 30 seconds (in the beginning of the game) to one real world second (in the end of the game). The process described above is much like real-time video games – for example, SimCity (see http://simcity.ea.com/).

The participant decision-making application includes the major business functions of a manufacturing company. Although we refer here to business functions, this does not mean that we regard the game as being a mechanistic view of a business entity with high differentiation of different functions, but rather as an open system of interrelated subsystems, with tasks and individuals belonging to a larger whole (Morgan, 1997). Furthermore, these game companies are able to play an active role in shaping their future by making decisions on which products to sell and which markets to function within. Morgan stresses that organizations are open systems best understood as ongoing processes rather than a collection of parts. This, we feel, describes quite well the functioning of *Realgame*. On the other hand, we feel

that the traditional batch processing in business games represents the mechanistic, Taylorian view of business organizations with its budget making process, where the top management makes decisions on behalf of the whole organization. *Realgame* starts by introducing the floor level business operations and then – as the participants develop their skills and knowledge about the business environment – proceeds step by step towards more holistic decisions.

Realgame's environment can be customized according to the case company's real world environment. This configurability concerns, for example, the market structure, the structure of the companies' internal materials process, the supply market structure, and so on. Through manipulating these parameters either before or during the training sessions, the game operator is able to radically change the game environment.

2 OVERVIEW OF THE CASE STUDY

Our research questions were the following:

1. How does the continuous processing element of *Realgame* affect participants' experiences and working processes?
2. What are the effects of configuring *Realgame* on participants' experiences and working processes?
3. Is working with *Realgame* beneficial to learning?

Alpha (a pseudonym) develops, manufactures and markets analytical systems, instruments, reagents and computer software for clinical diagnostics and biotechnology. It has a worldwide sales organization. Alpha products are highly technical and research and development has a central role in their operations. Alpha has more than 500 employees and its turnover is more than 100 M€.

2.1 The Configured Realgame Model

In the Alpha case the *Realgame* model was configured to substantially resemble the Alpha real-world environment. The process aiming at an authentic configuration included meeting Alpha key managers and game environment configuration. The configuration included the following customization:

- The manufacturing process was configured for two production lines.
- The markets and customers within the markets and their volumes and purchase behaviour.
- The general cost structure of the company.
- Raw material prices, terms of delivery, and terms of payment.

- The available delivery methods.
- External environment: loan interest, workers' terms of notice, the time from the machine investment decision to the point of time when the machine was in use, and so on.

This Alpha configuration is quite complex and being able to manage the configuration requires perquisite knowledge about the Alpha real-world environment.

2.2 The Participants

The 43 participants were well-educated managers or scientific experts from the Alpha main site. 38 participants answered our pre-game questionnaire (response rate 88.4 %), and these had an average work experience of 14.3 years and an average work experience of 8.7 years in Alpha.

26 (68.4%) of the participants had a master's degree, mostly in chemistry/biochemistry/ biotechnology/physics (N=12/31.6%), in some business subject (N=7/18.4%), or engineering (N=4/10.5%), but also some in sociology, languages, or computer science. Two had a PhD (5.3%), and 10 (26.3%) a BSc or equivalent. 23 (60.5%) stated that they had played business games before.

2.3 The Structure of the Game Sessions

The training sessions took place on 16th and 23rd of October 2002 (sessions A and B). In session A there were 21 participants (seven groups of three participants) and in session B, 22 participant forming eight groups (six groups of three, two groups of two participants). The training sessions lasted approximately 10 hours, breaks included.

There was one clear distinction between the two sessions. In session A the market volume was erroneously high, 10-fold compared to the total manufacturing capacity of the companies in the beginning of the game. This situation led to extensive capacity investments, resulting in two very different training sessions, as this error was corrected in session B. As there was excessive demand in session A there was no need for tight price competition and the most important thing to take care of was to try to deliver the orders in time, and, thus, avoid a drop in the company's image because of late deliveries. In session B the market demand was balanced with the total manufacturing capacity. In the results section we will analyze how this discrepancy between these sessions affected the participants' experiences.

3 COLLECTION OF EMPIRICAL DATA

The questionnaire used was delivered to the participants at the end of the training sessions. The first part of the questionnaire consists of 15 questions on a seven-point Likert scale and one Yes/No question. The structured questions of the first part measure the participant opinions on how well they thought the game represented different business phenomenon. The second part of the questionnaire consisted of five open-ended questions (introduced later).

4 RESULTS

4.1 Findings on the Statistical Data

When comparing the mean responses of participants in the two Alpha game sessions A and B (N=14 and 18) with T-tests, we can find three questions out of 15 questions in which these groups differed statistically significantly. These questions dealt with *the game ability to represent a holistic view of a company* ($p<0.01$), *how realistic was the uncertainty in the game* ($p<0.05$), and *the game was too complex* ($p<0.05$).

The significant differences in the first two questions in Table 1 can be explained with the production-focused nature of session A. The abundant customer demand in session A led to a situation where the problem was to fulfil all the incoming orders. This means that the participants concentrated heavily on the materials process. There was no need to pay that much attention to other functions like sales. This explains why in session B the participants had to deal with a more holistic view of the business operations. This same explanation applies also to differences in question 2 in Table 1.

The difference in the third question in Table 1 indicates that the abundant customer demand with excessive incoming orders created a situation where the participants where not equal to the requirements of the order management process and the order back-log piled up uncontrollable. However, the mean of the answers is still only 2.93 implicating a not too complex model.

Table 1. Comparison of the responses between Alpha training sessions A and B on selected questions.

Question	*Sess.*	*N*	*Mean*	*Std.dev.*	*t*	*df*	*Sig.*
(1) Game ability to represent a holistic view of a company (grades from 1/Poor to 7/Excellent)	*A* *B*	*14* *18*	*4.57* *5.61*	*0.938* *0.916*	*-3.152*	*30*	*0.004*
(2) How realistic was the uncertainty in the game (grades from 1/Poor to 7/Excellent)	*A* *B*	*14* *18*	*3.50* *4.50*	*1.225* *1.098*	*-2.430*	*30*	*0.021*
(3) Game was too complex (grades from 1/Disagree to 7/Agree)	*A* *B*	*14* *18*	*2.93* *2.11*	*1.269* *0.900*	*2.133*	*30*	*0.041*

The last question in the closed part was: *Did the game help you to get a holistic view of business processes (Yes/No)?* Here 93.7 % (N= 30) of the answers were positive. This implies that *Realgame* represents potential especially as a business process-training tool.

4.2 Findings on Open Ended Answers

Next we will go through the answers to the open part of the questionnaire. The participants were first asked: ***Did the game reveal something new about the flow of business processes?*** The answers were again mostly very positive. The only critical comments came from session A where the participants complained about the abundant market demand. One of the most accurate answers representing the general attitude of the participants to the question is this one: "*Best game (of three) that I have played, reflecting reality. The insights were to experience in a limited timeframe cause-effect relationships from a large number of functions/areas.*"

The second question concerned tailoring: ***Did tailoring enhance the learning experience?*** The vast majority of the answers were positive towards game tailoring. Several responses mentioned that it was easier to adopt the game environment as it was familiar to them: "*Tailoring was an excellent way to get the player into a familiar environment and have a better understanding of how everything goes in our own company. It also helped a lot in communicating with other team members.*" Some were also more critical, the next one representing possibly the most critical opinion (session

A): "*This tailor-made case was also confusing because the volumes were too high and people did not believe the figures.*"

Next the participants were asked: ***What do you feel you have learned during the training?*** The following answer comes from a person with a background in natural sciences: "*For me this was the first contact with running a business, so I suppose there were many important things. Maybe the most interesting thing was that within the group there was an old veteran, who made us to follow key figures (I myself would not have understood...).*" Mostly the answers concern the learning of some larger context and the complexity of the business entity: "*I learned about sequential dependencies and how long it really takes to affect production. In real-life, time can be multiplied by a factor of 10. I learned to think in a broader way – or should think in a broader way.*" Another answer describing the complexity in the game: "*The game made it very clear that the business itself is complex – it really opened my eyes and will hopefully remind me in the future to always take different points of view into account before decision-making.*"

Other learning topics that were mentioned were the sequential dependencies in production, financial key figures, management of the production process and purchases, timing in sales operations, pricing, and so on. Some respondents put nicely how impossible it was to make perfect decisions in an environment continually evolving: "*Act although there is not enough time to grasp all the possible factors. The importance to decide which factors to emphasize.*"

The next question proved to be difficult to answer: **How do you transfer these learned things to your current work?** Here the participants clearly had difficulties in explicating what they felt they had learned. The following examples give a good idea of typical answers: "*Maybe as an ability to take a bit more distance to decision making and try to view the whole picture before making decisions.*"

The following question deals with continuous processing: ***Do you feel that the continuous surveillance was an important feature of the game from the point of view of learning and understanding?*** The answers to this question were without exception very positive and almost all regarded continuous processing as a clearly important feature of the game: "*This feature was an important factor. It gives a possibility to see the whole process and not only to concentrate on inventories or sales or other functions.*" Several answers made reference to the real-world resemblance: "*Yes, I think it was, because that is realistic, you can't make just one decision and trust that it will work.*" Some also stated that continuous processing makes the game experience more engaging: "*Real-time playing makes learning more interesting.*"

The last question dealt with team working: ***Was the playing interesting, did you negotiate your decisions inside the group intensively?*** Again, the answers revealed that the participants' experiences about their team working were very positive and comparisons were made to other learning experiences: "*It was very enjoyable game, far better than the table board game I have earlier played.*" One respondent describes gaming as visual: "*More interesting and visual than other methods I have experienced. Decisions were negotiated which at the same time gives atmosphere of team-working.*" Here we cannot be sure whether the word visual means the game interface or the game processing method. However, continuous processing could also be described as visual as the processes evolve on-line on the computer screen. Therefore *Realgame* can be regarded as a shared frame of reference that could support and inspire collaboration and interaction between the participants: "*Playing was extremely interesting; we did a lot of negotiating during the game, even though we had slightly divided responsibilities.*" The following answer describes well the nature of decision-making: "*Very interesting & intensive day with continuous negotiation and decision making.*"

4.3 Summary of Findings

We will next answer the research questions. **Research question 1.** ***How does the continuous processing element of Realgame affect on participants' experiences and working processes?*** Based on the questionnaire answers the working in small groups proved to be very intense and engaging. *Realgame* seemed to maintain the task-orientation of the participants well over the long training day. The continuous processing element of *Realgame* helped the participants to see how the different business processes elaborated, emerged and linked together. Continuous processing represents authentically business processes and real world complexity. The participants thought that the game represented very well information flows and demands, sequential dependencies in operations and a holistic view of a company.

Research question 2. ***What are the effects of configuring Realgame on participants' experiences and working processes?*** The configuration of *Realgame* resulted in both positive and negative outcomes. On the one hand, the configuration shortened the time required for familiarization with the game and made it easier to understand the functioning of the game environment. On the other hand configuration caused some troubles, because the game model didn't resemble Alpha's real world environment with 100 % precision. Still we feel that we can claim that the game configurability increased the acceptability from the part of the participants. The answers to

the open part of the questionnaire give strong support for this. Besides its acceptability, configurability shortened the time the participants needed to get into the game model.

However, whether the game configurability increases the authenticity of the learning environment or not (resulting in meaningful working) is problematic to assess. Our questions were probably not perfect regarding this issue. For example, the next answer can be interpreted to both support and oppose this: "*It was good to have a realistic set of products and if this seemed complex, you can only imagine how it is in real life.*" In other words the respondent argues that the model included reality, but then again she makes a comparison to the more complex real world. Other comments give support for authenticity on a general level stating that it is easier to adapt to a game if it was tailored for a specific company. Some were very critical, especially in session A.

We believe that when we try to imitate the real world and make this aim explicit to the participants, they start to expect very accurate real world representations. In the Alpha case the deficit in the (possibly) expected authenticity did not spoil the learning experience but the general attitude towards gaming was still very positive.

Research question 3. ***Is working with Realgame beneficial for learning?*** We have noticed that what is learned through playing *Realgame* is not easy to recognize. The game participants clearly regard the gaming experience as useful, but they have difficulties in expressing what the concrete benefit was. However, according to the questionnaire answers *Realgame* helped them to construct a holistic view of the functioning of a manufacturing company, and to see the interdependencies between different business operations.

It seems to be the case that the Alpha participants faced problems when they tried to express the potential learning. There are several explanations for this: a) there was no learning; b) the learning that took place had not yet crystallized when they answered the questionnaire a week after the training; c) the learning that took place was by its very nature difficult to explain. We are referring to tacit knowledge, which involves both technical and cognitive elements, like mental models (individual's images of reality and visions for the future) and know-how, crafts and skills (as opposed to explicit knowledge that can be expressed in words and numbers; Nonaka, 1994). Our belief is that the true explanation is c), and partly also b). Unfortunately our research instruments were not quite capable to answer this proposition, but it is also true that the nature of learning from simulation working is very hard to tap with traditional test questions (Swaak, Joolingen & de Jong, 1998).

This leads us to the following comment regarding tailoring and authenticity. Configurability is probably useful for the learning outcomes if

one is to carefully plan how configurability will be presented and argued. Both the teacher and the learner have to understand that the real world resemblance is not a means to an end but an opportunity to increase participant motivation. A computer model can never accurately represent the real world. What is essential is that the participants experience meaningful decision-making problems and regard them as relevant to the real world.

5 CONCLUSIONS AND FUTURE RESEARCH

As a concluding comment we state that *Realgame* was found to be a very useful tool to be used in these in-house trainings. Participants regarded *Realgame* training as a very rewarding and interesting experience. But game customization is like a double-edged sword. On the one hand game configurability increases the participants' motivation, meaningful experiences and the possible transfer of learned knowledge and skills to real world working environment. On the other hand – since 100 percent precision in configurability is not possible – configurability can also cause misunderstandings and concentration on the not-realistic issues of a game which are irrelevant learning-wise.

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