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Applying an authentic, dynamic learning environment in real world business

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Abstract

This paper describes a dynamic computer-based business learning environment and the results from applying it in a real-world business organization. We argue for using learning tools, which not only provide realistic and complex models of reality, but are also are 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 introduced. In these sessions the learning environment was configured to describe the real-world environment of the case company. The empirical part of the paper analyses the findings from these in-house training sessions. We conclude that dynamicity and interactivity of the business learning tool are valuable characteristics if we want to be able to authentically represent the complex, causal, time-bound nature of business organizations.

Keywords: Simulation gaming; Business gaming; Business education; Interactive simulation; Authentic learning environments; Continuously processed learning environments

1. Background

There is evidence that often higher education has not managed to develop students' abilities to apply their knowledge in complex, ill-defined practical situations (Actenhagen, 1994; Lehtinen,

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2000). One of the main reasons for the inability of traditional teaching methods to facilitate the development of flexible and useful knowledge and skills is the lack of contextualizing or anchoring the content being learned. If content is separated from its authentic context, it will produce inert or impoverished knowledge. In such impoverished environments, learning becomes the memorization of seemingly abstract, self-contained entities (Barab, Hay, & Duffy, 2000). But the learning environment and learning tasks used should be authentic and reflect the complexity of the real life environment where learners are expected to be able to function after training (Savery & Duffy, 1995).

The above problems hold true also in business education (e.g. Mandl, Gruber, & Renkl, 1994). Another severe problem within business education (as well as in other subject domains) is difficulties in applying theoretical subject knowledge in real life settings, and the inability to handle complex and ill-defined problems. Inert knowledge cannot be applied in complex situations (Bransford, Goldman, & Vye, 1991), and even intermediate experts of economics may have enormous difficulties in applying their knowledge and skills in realistic problem-solving situations (Mandl et al., 1994).

Furthermore, Selen (2001) argues that in business education there is a lack of integration of all the ''traditional'' functional areas (e.g. accounting/finance, marketing, operations, management) in relation to evolving overall business models and strategies. Fragmented subjects that teach basic knowledge in each of their areas make it very difficult for students to develop coherent mental models about the business world and strategies as a whole. This is a clear example of stripping content out of context and conditions in which it is used; separating different domain areas from each other and from their realistic, intertwined existence. However, these problems cannot be solved just by cutting away the studies of theoretical, formal knowledge and replacing them with concrete, contextualized studies of informal knowledge. We must not neglect the learning of formal knowledge and the construction of abstract ideas (Lehtinen, 2002), but the need for ways to integrate theoretical and procedural knowledge is clear.

Typical solutions for these problems in business education have either been to use the case-based learning (CBL) approach or to integrate business simulation game training in business curriculum. The CBL method has been the more popular one of these two, and with it students' decision-making and problem solving skills are assumed to be facilitated. In business education the CBL method encourages students to explore and discuss real business cases allowing these example cases to be used as a stimulus and starting point for student-led learning processes. The major flaw in CBL is the static nature of the examined cases, which does not offer opportunities to understand the processes involved in the cases.

The other well-known method in business studies, business simulation game training, also has its strengths and weaknesses. Traditionally the games used in training have been batch-processed, which proceed in prescriptive cycles. This is problematic because the real world does not work in such a predetermined fixed order but decision-making is performed when the situation demands action, not afterwards when it may already be too late. Batch-processing offers a black-box view and prevents seeing evolving business processes. It, thus, gives a simplified view of organizational functioning and relationships between decisions and outcomes.

The main reason for the use of the business simulation game we describe here is to create an authentic and collaborative learning environment, where computer simulation is used as a tool for situating the business content being learned in its authentic contexts in a challenging way.

2. Theoretical background of designing the case learning environment

The theoretical principles that have guided our efforts to design the learning environment (*Realgame*) and the game training sessions described in this paper can be identified as follows:

- **Provide a realistic and complex model of business functions.** The authenticity of learning situations and tasks is assumed to be a very important factor in facilitating higher order learning (Brown, Collins, & Duguid, 1989). The basic idea is to anchor the learning of knowledge and skills into meaningful situations and the activities of everyday life (Barab et al., 2000; Goldman et al., 1996). In *Realgame* the problems and situations students face are designed to be very similar to those in real-life working contexts and students can apply their schooled knowledge and skills to them. The following *Realgame* attributes support the aim of creating an authentic learning environment. *Realgame* is **rich in detail**: The game creates business transaction specific data (i.e., presents single orders, deliveries, and payments, not just aggregate level data). For example, after a one day training the model company's cash flow database table may include several thousand cash events. Also, the game materials process is very detailed (described later in this paper). The game environment can be **configured** to resemble the case organization's real world environment (this is discussed later). Also, the continuous processing method authentically describes the **successive process nature of business transactions and operations**. This is illustrated particularly well in the representation of the material flow and in its links to the monetary process.
- **Facilitate continuous problem solving and meaningful learning**. One of the biggest challenges of education is to overcome the problem of inert knowledge. Technology-based learning environments can engage students in complex thinking about learning topics, which, in turn, can lead to better comprehension of the topics at hand and the development of useful learning skills (Jonassen, 2000). The main pedagogical basis behind *Realgame* is the idea of "learning with technology" (Jonassen, Peck, & Wilson, 1999), which is congruent with the constructivist perspective as seeing learning as an active meaning-making and knowledge-building interaction between learner, available tools and his/her social and physical environment.
- **Embed learning in social experience**. Learning is an inherently social-dialogical activity (Duffy & Cunningham, 1996). Collaborative working fits well with constructivist approach, and group work is used to share alternative viewpoints and challenge as well as help develop alternative points of view. The essential feature of the *Realgame* environment is the use of simulation in small groups (or teams) in such a way that every small group manages their own company and, thus, collaborative action becomes very important. In short, the environment aims to promote dialogical interchange and reflexivity among group members.
- **Support student's learning**. In addition to specific opportunities that the simulation offers to situate learning in realistic settings, it also offers the possibility to adapt reality to support learning (de Jong, 2001). Complexity and the numerous business transactions in *Realgame* are not impossible to manage for game participants because the **game speed** (clock speed**) can be increased gradually** during the training.

Realgame is a computer-based simulation game (for more about the concept of simulation games, see Saunders, 1995), which creates a complex and authentic-like environment for learning business studies. *Realgame* models the environment of up to eight manufacturing companies that compete against each other in a virtual computer network environment. Each participating company consists of optimally three human participants. The company decision-making application (each used by a student group) includes the main decision-making functions of a manufacturing company.

Traditionally, business games have been batch-processed. This means that the game participants create plans for their companies for a certain period (typically a few months or a year) in the immediate future. After having finished these plans (budgets), the plans and their figures are entered to the simulation model. The simulation model then calculates the results from these plans and generates a historic report. Thus, the simulation model is a black box within which the game participants have no internal view. To put it another way, the decisions and the results from them have no explicit cause-relationship as the black-box structure of the simulation prevents any direct participant interaction with the simulation processes. The forming of the cause-relationships is left for the participants to be created in their minds. In this formation process there is no guarantee that the learner creates a valid presentation of the cause-relationships.

Realgame, however, includes a clock-driven market engine on the server of a computer network, creating demand and supply. This construction is operated in real-time – continuously. The groups constantly exchange information with the market server over the network. This interactivity brings along some advantages not met in conventional, batch-processed games. Decision-making and feedback from the decisions made takes place in an interactive on-line mode. In this interactive model decisions are made as soon as they are needed or at least as soon as the decision-maker notices that the market or the company internal situation need 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 there are no budgeting cycles between the game periods but the game clock and game events keep on taking place continuously when the game clock is turned on. This resembles, e.g., modern production or process management information systems which monitor on-line the production processes. In *Realgame* this means that the game market application triggers the game internal clock in 1-h 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 s (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 processed video games – for example, SimCity (see, e.g., http://simcity.ea.com/).

Realgame is highly interactive in several ways. First, there is collaboration between the participating students within each team around the same computer. Secondly, the participants interact constantly with the game decision-making application (computer model of a manufacturing company) in their computer. Thirdly, each company application is in continuous interaction with the market server, and the participants can see these interactions through their game application interface. Finally, the participating groups are connected to each other through market information they receive, but they may also communicate 'informally' with each other during breaks.

The participant decision-making application includes the major business functions of a manufacturing company (production, purchases, sales, marketing, deliveries, funding, financial reporting, and so on). 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.

As a last feature of *Realgame* we introduce its configurability. The game's internal and external environment can be configured according to the case company's real world environment. This configurability concerns, for example:

- The market structure: how many market areas there are; how many customers within each; what is the volume and purchase frequency of each customer; what factors the customers value when they make their purchase decisions.
- The structure of the companies' internal materials process: how many production phases, how many production cells in each phase, which raw materials are required in each cell, what is each cells capacity, and so on.
- The suppliers' market structure: how many suppliers and which raw materials those suppliers supply, what is their delivery speed, price and term of payment for each raw material.
- Availability of external funding: available loans and interest rates.
- Company balance sheet structure and internal cost structure.
- The external environment: workers' salaries, terms of notice, cost of new production capacity, 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.

3. Overview of the case study

3.1. Research questions and propositions

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?**

Before we contacted our case company, we had several propositions regarding the usefulness of *Realgame* training. These propositions were mainly based on the theoretical principles described in Section 2, and are as follows:

Proposition A. *Continuous processing represents authentically business processes and real world complexity.*

Proposition B. *Game configurability (the resemblance to the case company's real world environment) will increase acceptability on the part of the participants.*

Proposition C. *Game configurability (leading to a familiar decision-making environment) will increase the authenticity of the learning environment resulting in meaningful working with the simulation.*

Proposition D. *Through increased authenticity the participants construct a deeper understanding of the phenomena studied.*

We were aiming at a relatively high level of complexity as this – according to constructivist principles – facilitates meaningful learning.

3.2. The Case company

Alpha (a pseudonym) develops, manufactures and markets analytical systems, instruments, reagents and computer software for clinical diagnostics, biotechnology and environmental monitoring. Its production is located in one site but it has a worldwide sales organization. Alpha products are highly technical and research and development has a central role in their operations. This is reflected in Alpha's employee profiles: a significant share of their employees have a degree in natural sciences and many of these have a PhD. Alpha has more than 500 employees (including the employees abroad) and its turnover is more than 100 M€.

3.3. 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 introduction of the idea of a configured training model and the training goals; Interviews of three Alpha key experts; Game environment configuration; Presentation of the first game configuration to the persons met earlier; Some minor modifications to the game environment were made; Intensive game tests; and The training sessions on 16th and 23rd of October 2002.

The configuration included the following game environment properties:

- The manufacturing process was configured to present two production lines: Systems and Test Liquid Kits (Fig. 1). The Test Liquid Kits line was the more complicated of the two. To introduce the diversity in the configured production process, Fig. 2 represents the game generic production line configuration used in university game sessions.

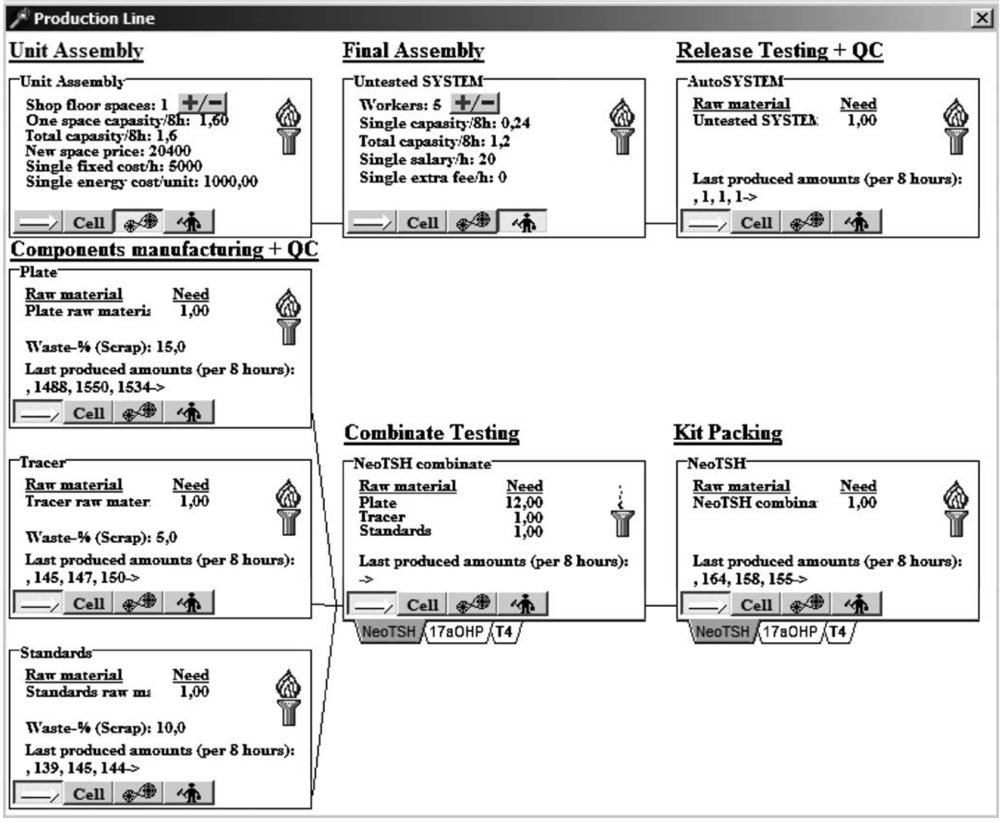


Fig. 1. Production line configuration in the Alpha case.

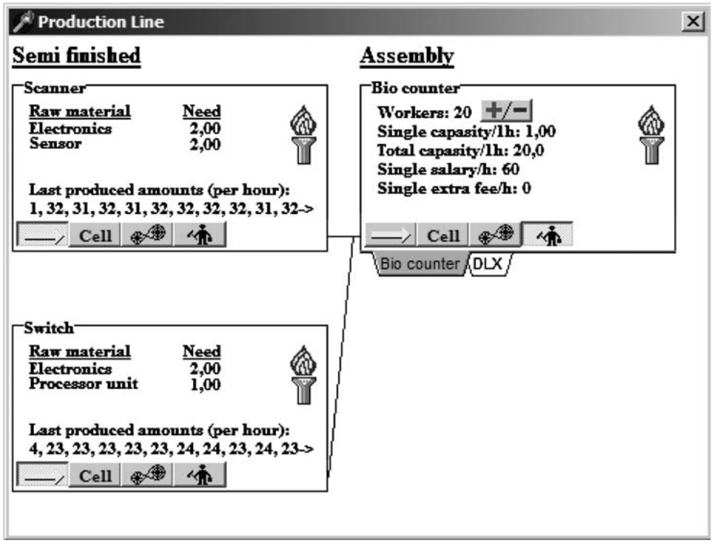


Fig. 2. The production process in the generic game version.

- The markets and customers within the markets and their volumes and purchase behaviour. Fig. 3 represents both the European market for Alpha and the generic game configuration used in university game settings.
- The general cost structure of the company. This included the balance sheet structure and cost structure of Alpha fixed costs.
- Raw material purchases: raw material prices, terms of delivery, and terms of payment. Special emphasis was given to realistic material delivery times to simulate the typically long delivery times of Alpha suppliers.
- The available delivery methods were configured to resemble the long delivery time to far-away global markets.
- External environment: loan interest, currency, 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.

Fig. 2 represents the game generic production line structure. In normal student training this structure has been noted to be complex enough. Fig. 1 shows the Alpha production line configuration. It should be quite obvious that this configuration is much more complex than the generic version. To give some figures, the generic model uses four different raw materials and the Alpha configuration uses nine different raw materials. In addition, in the Alpha configuration the participants have to steer two different production lines compared to one line in the generic version.

Fig. 3 represents the market structure of one specific market area in both the generic game version and the Alpha version, named Europe in both configurations. These do not differ much from each other in complexity, but the Alpha version is more authentic to the Alpha employees as the market is real, the countries and their volumes within the market are realistic, and the purchasing behaviour of the customers is supposed to be similar to real world customers (how they value, e.g. the price and quality of the products).

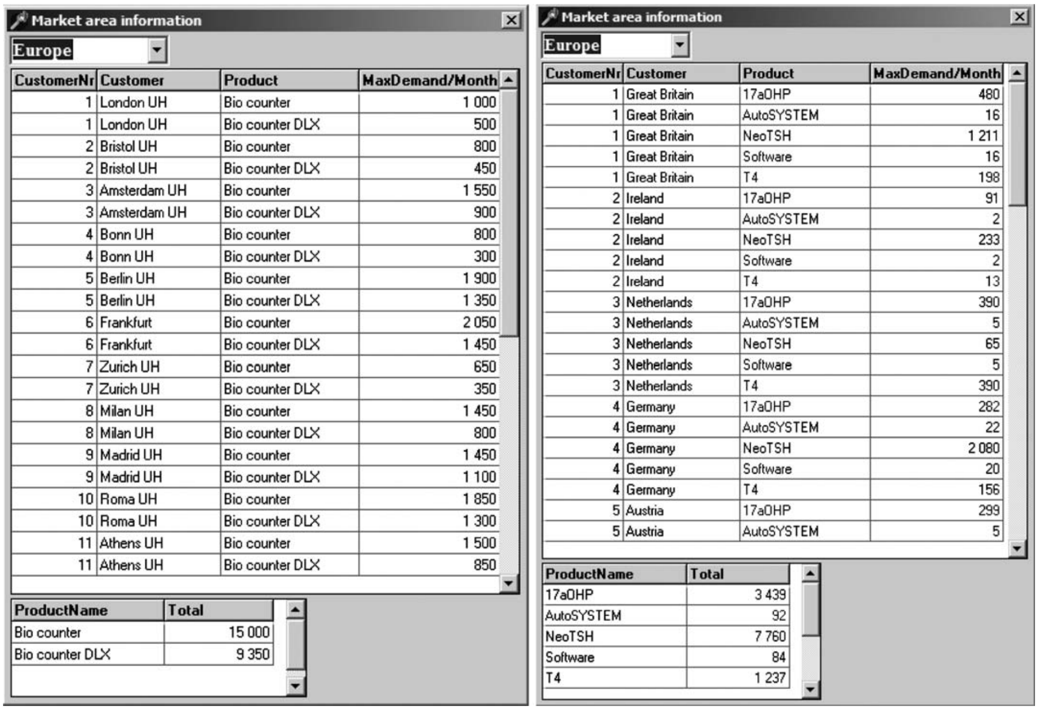
3.4. The participants

The 43 participants were well-educated managers or scientific experts from the Alpha main site. The participants participated in the training on a voluntary basis. Thirty eight 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.

Twenty six (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. Twenty three (60.5%) stated that they had played business games before.

3.5. The structure of the game sessions

The training sessions took place on 16th and 23rd of October 2002 (referred to as sessions A and B from this point forward). 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).



Market area information

Europe

CustomerNr	Customer	Product	MaxDemand/Month
1	London UH	Bio counter	1 000
1	London UH	Bio counter DLX	500
2	Bristol UH	Bio counter	800
2	Bristol UH	Bio counter DLX	450
3	Amsterdam UH	Bio counter	1 550
3	Amsterdam UH	Bio counter DLX	900
4	Bonn UH	Bio counter	800
4	Bonn UH	Bio counter DLX	300
5	Berlin UH	Bio counter	1 900
5	Berlin UH	Bio counter DLX	1 350
6	Frankfurt	Bio counter	2 050
6	Frankfurt	Bio counter DLX	1 450
7	Zurich UH	Bio counter	650
7	Zurich UH	Bio counter DLX	350
8	Milan UH	Bio counter	1 450
8	Milan UH	Bio counter DLX	800
9	Madrid UH	Bio counter	1 450
9	Madrid UH	Bio counter DLX	1 100
10	Roma UH	Bio counter	1 850
10	Roma UH	Bio counter DLX	1 300
11	Athens UH	Bio counter	1 500
11	Athens UH	Bio counter DLX	850

ProductName	Total
Bio counter	15 000
Bio counter DLX	9 350

Market area information

Europe

CustomerNr	Customer	Product	MaxDemand/Month
1	Great Britain	17aOHP	480
1	Great Britain	AutoSYSTEM	16
1	Great Britain	NeoTSH	1 211
1	Great Britain	Software	16
1	Great Britain	T4	198
2	Ireland	17aOHP	91
2	Ireland	AutoSYSTEM	2
2	Ireland	NeoTSH	233
2	Ireland	Software	2
2	Ireland	T4	13
3	Netherlands	17aOHP	390
3	Netherlands	AutoSYSTEM	5
3	Netherlands	NeoTSH	65
3	Netherlands	Software	5
3	Netherlands	T4	390
4	Germany	17aOHP	282
4	Germany	AutoSYSTEM	22
4	Germany	NeoTSH	2 080
4	Germany	Software	20
4	Germany	T4	156
5	Austria	17aOHP	299
5	Austria	AutoSYSTEM	5

ProductName	Total
17aOHP	3 439
AutoSYSTEM	92
NeoTSH	7 760
Software	84
T4	1 237

Fig. 3. Market Europe (customers and their estimated purchase volume) in the game generic version (left) and the configuration in the Alpha case (right).

The training session day structure was approximately the following. The day started at 8:15 (from "January") with an introduction to the theme of the training and rules of the game. After this the clock was turned on but run very slowly (1 game hour equals 30 real world seconds). During the day the game was occasionally stopped and financial reports run (profit calculation, financial key figures). The participants were given time to analyze the game process and to create plans for their future operations. Gradually the clock speed was increased to the maximum (1 h = 2 s). At 17:20 the game ended and the clock was turned off ("August"). The gaming part of the session was stopped. The final situation reports were run, and analysis and game debriefing performed. The winner was selected. At 18:10 the session was ended.

There was one clear distinction between the two sessions. During session A it became clear that the market volume was erroneously high compared to the manufacturing volumes of the seven competing companies. The market volume was 10-fold compared to the total manufacturing capacity of the companies in the beginning of the game. This situation led to extensive capacity investments in the game companies in session A, 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 price level remained substantially higher than in session B. So, in session A 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 of the participating companies. In the results section we will analyze how this discrepancy between these sessions affected the participants' experiences and feedback statements.

4. Collection of empirical data

The primary unit of analysis was the gaming session and the participants in the game. The possible outcomes to be described included participant opinions on the usefulness of the game as a business process learning tool, and description of the learning that took place. To study these we used several data gathering methods described next.

It seems that by its very nature the results of simulation are so qualitatively different from just acquisition of new factual knowledge that those effects cannot be detected by traditional knowledge tests (c.f. Swaak & de Jong, 1996). Swaak, van Joolingen, & de Jong (1998) concluded that it is not clear how the effects of learning from simulation are to be measured. Further, they inferred that simulation produces intuitive (or implicit or tacit) knowledge, which tends to be difficult to verbalize and to measure. As a consequence from the analysis problems with our earlier tests we decided to interview some of the participants after the sessions.

4.1. Game questionnaire

The questionnaire (Appendix A) used was delivered to the participants at the end of the training sessions and the participants were asked to return the questionnaire to the human resources department.

The question selection was based on the business phenomena represented in the game. This questionnaire had previously been used in other company in-house training sessions. The first part of the questionnaire has changed only slightly during the last 1.5 years, but the second part has always been customized according to the themes of the training.

The first part of the questionnaire consists of 15 questions using structured 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, e.g., business functions, flow of time in business organizations, enjoyment of gaming, etc. The answer scale for these questions was either from 1/Poor to 7/Excellent, or from 1/Disagree to 7/Agree.

The second part of the questionnaire consisted of five, unstructured, open-ended questions. Here the participants were asked to say, e.g. how well the game represented the business processes, did the tailoring of the game environment enhance the learning experience, and what the participants felt they had learned during the training.

4.2. Post-game interviews

Two groups were interviewed (one from session A, one from session B). The group in session A was interviewed exactly three weeks after the game training, and the group in session B was interviewed two and a half weeks after the training. In the interview we used a predetermined list of questions, but the discussion was let to roam to themes that popped up during the interviews. The interviews were tape-recorded and transcribed.

5. Results

Next we will present the findings. First, we will report findings from the post-game interviews. Secondly we will proceed to findings based on game questionnaire, and introduce both statistical analysis of quantitative data and qualitative dissection of the open-ended feedback questions. Finally we will summarize our findings and compare them to our propositions.

5.1. Findings based on post-game interviews

Here we will mention the most interesting comments during the interviews. First of all, the reception *Realgame* received in Alpha was positive (group A): "*Yes, otherwise this would not have been discussed so much around the coffee table; where the game could be employed. This was a fabulous business. It is not just about learning but building up team spirit*." This supports our Proposition C (working is meaningful). Group A also describes the reason for this meaningfulness: "*The game created a feeling of ownership, a kind of an intensive feeling of being in the middle of a struggle*." The game was considered to be very intensive and raised thinking also after the game sessions (group A): "*A couple of days after the game there was still a lot of talk about the game. That is because the playing was so intense and the game pulled us along, and after the game when the steam had cleared, it was interesting to know what the others had done and why.*"

Proposition A assumes that continuous game processing authentically represents real world complexity. Group A mentioned descriptively the difference they found between Realgame and batch-processed games: "*A batch-processed game is strategically easier to play because it creates an ideal model: if you know the theories, you can cope with that information and playing becomes too easy. In Realgame it is much more difficult to succeed although one knows about the theories. In batch processing the decisions are entered by decision terms and then the game proceeds and that is all you have to do. Continuous processing corresponds better to real life because when the game proceeds you can see the whole process.*"Thus, continuous processing brings along the un-predetermined and complex nature of the real world. What increases the complexity of continuous processing is that several different processes are going on at the same time. But this complexity is, after all, not impossible to be managed as the processes are transparent (group B): "*Definitely an advantage* [continuous processing]. ... *But it was a big plus that it was continuously processed, so that you could see all the time what would happen*."

Through continuous processing and the complex environment the intensity of gaming was also emphasized (group B): "*Yes, it probably did increase the intensity... In those board games I have played one does not get into it that well, they do not bring along the complexity that nonetheless exists in business life*."

Proposition B (configurability will increase the acceptability) gets indirect support (group B): "*One thing that one surely learned to understand was how complex this whole business is; that there is an enormous amount of different factors*". Thus, the interviewee expresses the configured complexity in a positive way. Another indirect comment supporting this proposition: "*Yes surely, gave new weight to my thoughts: Take seriously what I have suggested. Software should be regarded equal to other products. So, I can now refer to this game and state that focusing on producing software was successful in the game: one can success by distinguishing from others and focusing.*" In other words the interviewee regarded the game configuration so authentic that he planned to use the game experience as a reference in real world negotiations.

Acceptability can also be found in the comments about learning during the game (group A): "*This* [what was the most important thing they learned] *is easy to answer. For me it was the processes of Liquid Kit production. That is what I learned. It* [the game] *gives a higher level of understanding about the thing. – For me it is more about the whole, no single thing, that how the things affect each other."* The above comments also support Proposition D (through increased authenticity the participants construct deeper understanding). Indirect support for Proposition B can be found from this comment (group B): "*A game this demanding requires a group of participants who know something and understand what the functions are. It is no use involving juniors or people from production who are not familiar with the decision-making process. The group participating now was quite good.*" This comment reveals that the tailored model was well accepted and was regarded as authentic, requiring "higher level skills" from the participants.

As some of the comments described above have also revealed, Proposition C (configurability will increase authenticity) gets mixed support from the interviewees. The configured game model was not considered to behave as the real world would (group B): *"We made a radical shift in operations that would not be possible in reality. If we don't start thinking that this kind of business operation* [software production] *was totally be outsourced, as a start-out. So, in that sense it was not realistic. And when we did outsource, the overheads* [administrative expenses, mostly originating from production] *still remained. In that sense it was not realistic... But compared to some other similar games that I have played I would say that here realism had been captured better than in board games. – Yes, that is true.*"

Still, configurability increased authenticity only if the participants were familiar with the Alpha environment (group B): "*For me it did not* [tailored game model made it easier to get into the model]*, I do not know the kits and systems production at all. I have worked here a bit more than a year. I have had enough challenge to get familiar with my own work tasks and have not had time to familiarize how our business functions.*" It seems to be the case that when a game environment is marketed as being realistic, some extra expectations arise. Thus, the participants pay plenty of attention to whether the game processes and properties correspond exactly to the real word environment, not whether the resemblance is on a sensible level regarding learning relevant real world problems.

Some of the participants were very serious about the difference in the logic of selling systems in the real world versus in the game. For us, as game operators and responsible for configuration, how important this particular market logic aspect was came as a surprise. This serves as an example of how difficult tailoring is. A single, but central, business logic difference between the game and the real world can considerably affect how the participants experience the game model.

Apart from comments regarding our proposition, there were some other interesting comments. The next describes how the abundant customer demand was dealt with (group A): "*Probably the best business game I have played. And I have heard similar comments from others. Everybody understood the bug* [abundant customer demand]. *In a way that taught as well.*" Thus, the mistake in customer demand did not spoil the learning experience, but might also have introduced some learning that might not have been possible without the mistake. In this case the erroneous situation gave the participants extra hard lessons on how difficult it is to increase production capacity and how important it is to keep to promised delivery times.

5.2. Findings on the statistical data of the game questionnaire

The structured part of the questionnaire (Appendix A) consisted of seven-point Likert scale questions dealing with participants' experiences and feedback of game working. First we will introduce the results from both of these particular Alpha training sessions and make comparison between these. After that we compare these Alpha training sessions with our three previous company in-house trainings.

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 significantly statistically. 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* ($p < 0.05$). (Table 1 below). In other questions there were no significant differences between these Alpha game sessions.

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 led to a situation where there was no need to actually compete with the other teams, but the problem was to fulfil all the incoming orders. This means that the participants concentrated heavily on production and raw-material purchases. There was no need to pay that much attention to other functions like sales and scanning the market situation. 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 the 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 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.

To see how game tailoring affected the feedback responses, we can compare the responses from these configured Alpha sessions ($N = 32$) with responses from three previous *Realgame* in-house training sessions ($N = 46$, called 3P from this point forward) using the generic game model. These two comparable groups differed significantly in their responses to four questions in the first part of the questionnaire (the first part of the questionnaire has been the same in all the sessions). The participants in the 3P sessions evaluated more positively the *fluency of gaming* ($p < 0.01$), the *game ability to give feedback on decisions* ($p < 0.01$), the *level of realism in the game* ($p < 0.001$), and *game process correspondence to reality* ($p < 0.01$) (Table 2 below).

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

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

Table 2
Comparison of the responses between Alpha training sessions and 3P session on selected questions (grades from 1/Poor to 7/Excellent)

Question	Session	*N*	Mean	SD	*t*	df	Significance
(1) Fluency of gaming	3P	46	5.93	1.020	2.954	76	0.004
	Alpha	32	5.22	1.099			
(2) Game feedback ability	3P	45	5.47	1.120	2.807	75	0.006
	Alpha	32	4.69	1.306			
(3) Level of realism in game	3P	46	5.54	0.912	4.534	47.280	0.000[a]
	Alpha	31	4.26	1.390			
(4) Game correspondence to reality	3P	46	4.98	1.256	2.969	76	0.004
	Alpha	32	4.13	1.238			

[a] Variances not equal.

One possible reason for the difference in question 1 (Table 2) may be the overall model complexity in the Alpha case, which made it more difficult to manage the whole business environment. This same problem can also partly explain the difference in question 2, though there are probably some other reasons too. E.g. the Alpha training session were so short that the participants did not have enough time to familiarize themselves with the reports.

Questions 3 and 4 deal with the same phenomena. The difference between Alpha and 3P within these questions was the most surprising finding. Obviously the Alpha participants regarded the Alpha configuration as being highly realistic but, however, clung to the differences between the Alpha model versus real world.

The analysis of Fig. 4 reveals that there were no big differences in terms of the questions represented here, except for the statistically significant difference in the question concerning game complexity discussed earlier.

Figs. 4 and 5 show participant opinions on different game characteristics between Alpha participants and the participants in 3P.

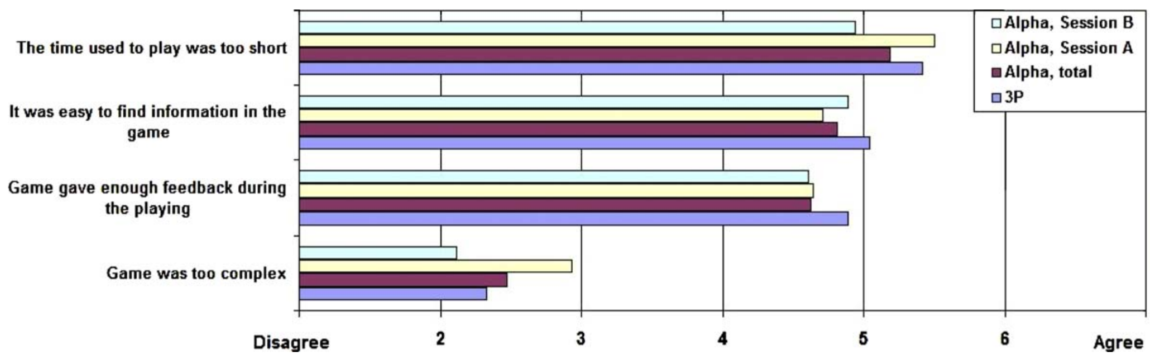


Fig. 4. Answers to the questions 1–4 in the structured part of the questionnaire in the Alpha and 3P cases (answers on scale 1/Disagree to 7/Agree).

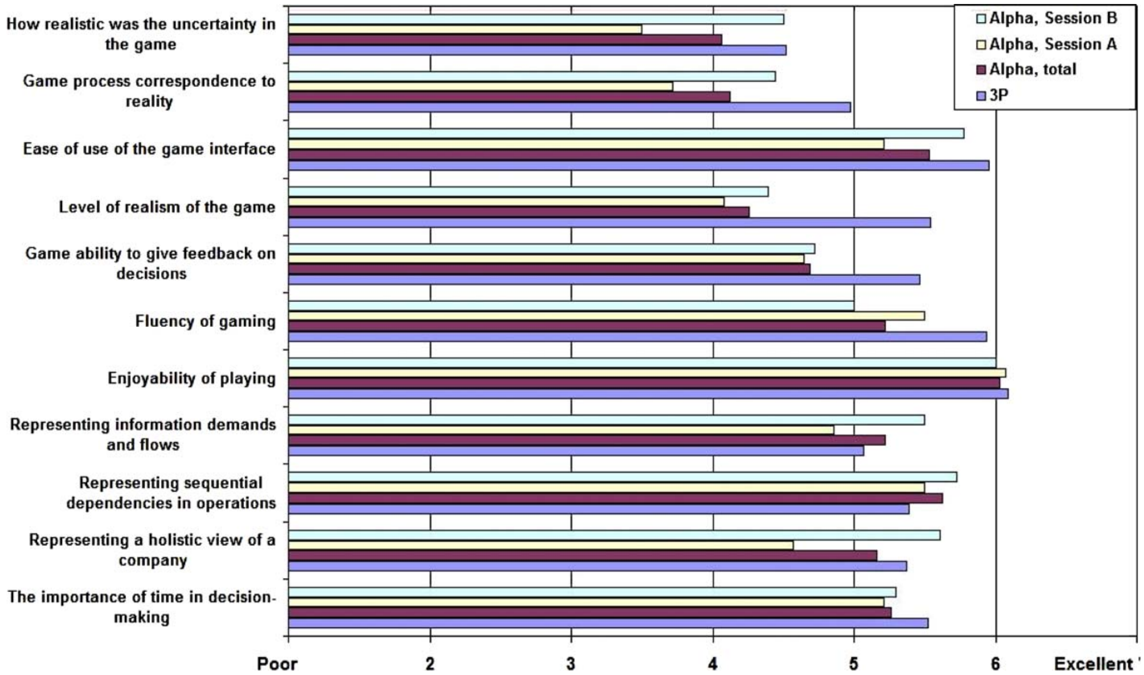


Fig. 5. Answers to the questions 5–15 in the structured part of the questionnaire in the Alpha and 3P cases (answers on scale 1/Poor to 7/Excellent).

Analysis of Fig. 5 reveals that Alpha participants regarded the game configuration to be less realistic compared to the generic model of 3P, especially when we have a look at session A. This is the biggest surprise from the analysis of the questionnaire answers and raises some questions concerning our Proposition C (*Game configurability will increase the authenticity of the learning environment*). All of the three questions concerning game realism got lower grades in the Alpha case than in the 3P cases. Also, in three other questions Alpha participants were more critical than 3P's (*Ease of use of the game interface; Game ability to give feedback on decisions; Fluency of gaming*). The reason for this can partly be the complexity of the Alpha version, but also the faster game clock speed, and the amount of breaks during the training day.

The rest of the answers in Fig. 5 receive similar grades from both Alpha and 3P participants. In the cases of the questions *Representing information demands and flows* and *Representing sequential dependencies in operations* the Alpha case received slightly better results than the 3P cases.

The last question in the closed part was: *Did the game help you to get a holistic (to see the whole structure) view of business processes (Yes/No)?* Here 93.7% ($N = 30$) of the answers were positive and 6.3% negative ($N = 2$). This clearly implies that *Realgame* represents potential especially as a business process-training tool.

5.3. Findings on open ended answers of the game questionnaire

Next we will go through the answers to the open part of the questionnaire. The participants were first asked: ***How well did the game represent business processes? Did the game reveal something***

new about the flow of business processes? If it did, what were these new insights? 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 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: ***The game was tailored for the Alpha environment, on a general level. Did this tailoring enhance the learning experience? Where was the real-world resemblance successful and where not?*** Again 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.*" As the answer above suggests the participants took well, for the most part, the abundant customer demand in session A. 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. No realistic figures!*"

Next the participants were asked: ***What do you feel you have learned during the training? What do you think was the most important thing you learned?*** How the participants answered depended of course on their educational and professional background. 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...).*" Those answers clearly mentioning some business decision-making problems were quite few. Mostly the answers concern the learning of some larger context and the complexity of the business entity, like the following: "*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.*"

Only a few gave something concrete as the answers here:

- *I try to bring the crucial product information to the process, leading to a faster time to market and better added value.*
- *This will improve my understanding of timeline decisions for new products.*

The following question deals with continuous processing: ***As Realgame is continuously (real-time) processed it demands the participants to continuously follow market events and update their strategies. Do you feel that the continuous surveillance was an important feature of the game from the point of view of learning and understanding? Why?*** The answers to this question were without exception very positive and almost all regarded continuous processing as a clearly important feature of the game. The next answer nicely expresses the link between continuous processing and business processes: "*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. Helps people to understand importance of co-operation between the 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 motivating or engaging: "*Real-time playing makes learning more interesting.*"

The last question dealt with team working: ***How would you describe your working with Realgame. Was the playing interesting, did you try to understand the function of the market, did you negotiate your decisions inside the group intensively etc.?*** 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 a very enjoyable game, far better than the 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 participants in small groups. Several described the nature of co-operation within the game team: "*Playing was extremely interesting; we did a lot of negotiating during the game, even though we had slightly divided responsibilities (one to look at production, one to market demand, one to competitors' actions)*." The following answer describes well the nature of decision-making: "*Very interesting* & *intensive day with continuous negotiation and decision making*."

5.4. Summary of findings

To conclude the findings of our study we will next answer the research questions and propositions.

Research question 1. *How does the continuous processing element of Realgame affect on participants' experiences and working processes?* 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.

Proposition A. *Continuous processing represents authentically business processes and real world complexity.*

Our results clearly give support to this proposition. The attitude of the participants probably more clearly supported this proposition than any other of our proposition. The participants thought that the game represented very well information flows and demands, sequential dependencies in operations and a holistic view of a company. The participants did not give quite as good grades for the game process correspondence to reality, but this is probably not due to the processing method of the game but rather due to problems with the tailoring.

Research question 2. *What are the effects of configuring Realgame on participants' experiences and working processes?* The configuration of *Realgame* for Alpha 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 did not resemble Alpha's real world environment with 100% precision.

Proposition B. *Game configurability* (*the resemblance to Alpha's real world environment*) *will increase the acceptability from the part of the participants.*

As with Proposition A, it is quite easy to note that the Alpha participants accepted the configured game model well. This would imply that a configured/tailored game model did not decrease the acceptability of the game, although the participants felt that the configured model did not represent the Alpha environment accurately. The answers to the open part of the questionnaire give strong support for this proposition. Besides its acceptability, configurability shortened the time the participants needed to get into the game model.

Proposition C. *Game configurability will increase the authenticity of the learning environment resulting in meaningful working with the simulation game.*

This proposition is somewhat problematic. Our questions were probably not perfect regarding this issue. For example, the next answer can be interpreted to both support and oppose Proposition C: *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.

If we look at the closed part of the questionnaire, we see that the participants – although the game model was tailored – regarded the game environment to be considerably less realistic than that the 3P participants thought about the generic game model. This implies 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.

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 from the session was. According to the participants' interviews and 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. In other words *Realgame* introduced a process view of business to the participants.

Proposition D. *Through increased authenticity the participants construct deeper understanding of the phenomena studied.*

To answer whether this proposition is true or not is problematic. It seems to be the case that the Alpha participants faced problems when they tried to express the potential learning that took place during the gaming sessions. 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 as mentioned earlier the nature of learning benefit from simulation working is, by its nature, very hard to tap with traditional test questions (Swaak et al., 1998).

This leads us to the following comment regarding tailoring and authenticity of computerized learning environments. 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 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 environment.

6. 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. *Realgame* seemed to be able to introduce the complex nature and interdependencies of the functioning of the business to the participants, that is to say the process view of business. *Realgame* inspired intense interaction and collaboration between the team members.

Another important thing we found out during this case study was the effect of the game environment configuration. The configuration 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% precision in configurability is not possible in a game environment – configurability can also cause misunderstandings and concentration on the specific, not-realistic issues of a game which are irrelevant learning-wise. As a business environment normally is very complex and dynamic, the configuration of a learning environment is a difficult and demanding task.

Our belief is that as long as we do not have tools with which to look directly at the minds of the learners, the best way to assess the learning that takes place in this kind of complex, dynamic and multidisciplinary environment is to interview the participants. During interviews the participants can express their feelings and opinions on issues that are not explicitly dealt with in questionnaires. During interviews the interviewer can direct the discussion to those areas that are relevant regarding the learning. We also believe that discussion during an interview can lead to *Externalization* (Nonaka, 1994), which means the conversion of tacit knowledge into explicit knowledge.

Support for this argument can also be found from other sources. Jonassen et al. (1999) argue that knowledge building requires articulation of what is learned. For usable knowledge to be constructed, learners need to think about what they did and articulate what it meant (verbal, visual, auditory). In other words, in addition to the gaming session there needs to be a de-briefing session that helps the participants to mature or develop what they have learned. We believe that to be successful this de-briefing session needs to be arranged clearly after the training in small groups where all the participants have the possibility to express their feelings. In our two interviews we felt that the interviewees were very motivated to speak and had a quest to express their opinions on gaming. Thus, an interview serves two purposes: it was a possible learning situation for the participants as well as data gathering method for the researchers.

Appendix A

The questionnaire used in the Alpha training sessions.

1. Please give a grade for *Realgame* in respect of the following game properties. In other word, how well did the game describe the property in question? (circle)

The importance of time in decision-making	Poor 1 2 3 4 5 6 7 Excellent
Representing a holistic view of a company	Poor 1 2 3 4 5 6 7 Excellent
Representing sequential dependencies in operations	Poor 1 2 3 4 5 6 7 Excellent
Representing the importance of information demands and flows	Poor 1 2 3 4 5 6 7 Excellent
Enjoyability of playing	Poor 1 2 3 4 5 6 7 Excellent
Fluency of gaming	Poor 1 2 3 4 5 6 7 Excellent
Game ability to give feedback on decisions	Poor 1 2 3 4 5 6 7 Excellent
Level of realism in the game	Poor 1 2 3 4 5 6 7 Excellent
Ease of use of the game interface	Poor 1 2 3 4 5 6 7 Excellent
Game process correspondence to reality	Poor 1 2 3 4 5 6 7 Excellent
How realistic was the uncertainty in the game	Poor 1 2 3 4 5 6 7 Excellent

Game was too complex	Disagree 1 2 3 4 5 6 7 Agree
The game gave enough feedback during the playing	Disagree 1 2 3 4 5 6 7 Agree
It was easy to find information in the game	Disagree 1 2 3 4 5 6 7 Agree
The time used to play was too short	Disagree 1 2 3 4 5 6 7 Agree

2. Did the game help you to get a holistic (to see the whole structure) view of business processes? Yes/No
3. How well did the game represent business processes? Did the game reveal something new about the flow of business processes? If it did, what were these new insights?
4. The game was tailored for the Alpha environment, on a general level. Did this tailoring enhance the learning experience? Where was the real-world resemblance successful and where not?

5. (a) What do you feel you have learned during the training? What do you think was the most important thing you learned? (b) How do you transfer these learned things to your current work?
6. As *Realgame* is continuously (real-time) processed it demands the participants to continuously follow market events and update their strategies. Do you feel that this continuous surveillance was an important feature of the game from the point of view of learning and understanding? Why?
7. How would you describe your working with *Realgame*. Was the playing interesting, did you try to understand the function of the market, did you negotiate your decisions inside the group intensively etc.?

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