Designing Game Based Learning – a Participatory Approach

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Abstract: Game Based Learning seems to be an interesting new possibility of teaching and learning, but the effort spent on designing games and the possible positive outcomes have to be weighed carefully. The following paper describes the development process and the conceptual design of a simulation game on sustainability for teenagers. The design process is participatory in nature. Members of the future group of learners are involved in the design process at every stage. This involvement is especially important to overcome the contradiction between the goal of the game as such and the pedagogical goal of the designers.

1. Introduction

The topic of sustainability is gaining importance in public discourse. Despite the extensive media coverage many people still possess too little information about this topic, especially about sustainable product design. This is all the more problematic as informed consumers might influence product design by either buying sustainable products or not. Unluckily, most people are not able to make such informed decisions. Teaching children at school about sustainable product design might overcome this problem. It must be pointed out, however, that more traditional approaches of teaching might not get the desired results. Decisions about buying articles of daily consumption are often based on fashion and life-style and contribute to defining a person's own identity. Changing peoples' attitudes in this area is a more difficult process than just providing them with additional information. In addition, sustainable product design is a very complex domain, and it is not trivial to represent the interdependencies between different factors influencing it. We, therefore, decided to develop a simulation game to convey information about this topic and also to motivate teenagers to examine this topic in a comprehensive way.

Using Game Based Learning has become more popular in recent years, among others because of the increasing power of PCs. Nevertheless, many authors point out that there is still too little systematic and conclusive research in this area (see e.g. Akilli 2007, Tennyson & Jorczak 2008). Using learning games in school can, therefore, only be done on an experimental level as little is known about what makes a learning game successful. In recent years, interest in Game Based Learning has also increased because of the widespread use of Massively Multiplayer Online Games (see e.g. Steinkuehler 2004). Such games especially support team work and collaboration between learners although some authors point out that collaboration in such games is not as prevalent as commonly assumed (Ducheneaut, et al. 2006). Duchenaut et al. assume that, nevertheless, collaborative online games can foster mutual support and encouragement. Thereby collaborative online games can help learners to learn more effectively (Tennyson & Jorczak 2008).

In general, computer games are supposed to result in positive effects because of the increase in motivation (Malone 1980). There is some indication that cognitive abilities as e.g. visual abilities or problem-solving skills are improved by game based learning (see e.g. Akilli 2007). On the other hand, there are also serious problems which have to be considered when developing learning games (see e.g. Kickmeier-Rust 2006). Games have, per definition, no external goals but are played because they are fun. In contrast to that learning systems always have external goals, that is, to learn some topic defined by a teacher. This contradiction is often difficult to overcome in the design of learning games. As a game designer, one often has to decide whether to make the game fun to play but conveying little information or highly informative but boring to play. In addition, the cost for the development of learning games of good quality is still very high. Learning games have to compete with professional computer games, otherwise they will not be taken seriously.

The following paper describes the development process of a learning game about sustainable product design. The goal of the game is to increase the students' awareness about the issue of sustainability and help them to make better decisions as consumers in the future.

2. Game Concept

The aim of the SuLi simulation game is to enable young people to make informed decisions when acquiring consumer goods und take ecological as well as economic and social considerations into account. In addition, the game is supposed to introduce young people to Life Cycle Thinking – that is an approach which encompasses the whole life cycle of a product from the production of the materials to the possible reuse of the components after the product has been discarded. To achieve this, the game offers information about global interdependencies in the economy and sustainable alternatives to the current situation in the world's economy.

In the SuLi (Sustainable Living) game, the players' task is to produce goods of daily life and to consume these goods which means that in most cases they have to buy goods from each other. The goods which are traded (e.g. food, clothing, household goods, hygiene, communication, media, leisure and sports) reflect young peoples' everyday experience. An important feature of the game is that every player's actions influence the other players' situation. The state of the SuLi universe is, therefore, a result of all the players' activities. Production and consumption of all participants are the basis for the computation of the ecological, social and economic changes in the SuLi universe.

Every player gets an avatar who is living on his or her own island (see fig. 1). These islands are characterized by a different supply of raw materials, social standards and ecological and economic conditions. As no island is equipped with all necessary raw materials, trade is necessary. The game is based on a concept of rounds. In every round, players decide which goods to produce, where to produce them, which raw materials are used, what means of transportation are adopted and what the price of the good should be. It is also possible to build a factory for a product on another island (the home of another avatar). A possible reason for this might be that the consequences of production (i.e. pollution) should take place on another island. By selling products the players receive their income so that they can buy goods to stay alive and increase their health and well-being. Players have to take care about limited raw materials (especially oil) because these tend to run out. Renewable energy and recycling should be used by all players to keep the game going.

The situation on the islands changes as a consequence of production processes. The avatar develops because of consumption and as a result of the social and ecological situation on the island an avatar inhabits (see fig. 2). If this situation is very unpleasant or he or she consumes too little the avatar dies. The avatar not only needs food and clothing but also means for communication and recreation to increase his or her well-being. The game is based on a simulation working in the background. An important aspect of the game should be the exploration of the interdependencies between various actions and developments. By trying out different strategies, young people should be able to devise different scenarios for policies in the area of ecological and economic development. They should also experience which parameters might influence this development. Players will soon find out that an individualistic strategy (maximizing the profit of one’s own avatar) will eventually lead to the ruin of the SuLi universe and cooperation is necessary to survive. A chat facility enables players to communicate with each other during the play to synchronize strategies.

The product data for the simulation (sustainability for the materials, of transport, possibility of recycling, etc.) were collected for the whole product life cycle and in the areas of ecology, economy and social conditions. They are the result of extensive scientific research and were calculated with SimaPro (SimaPro 2007). The development of a product is possible in different ways (more or less sustainable). Data like energy used for the production, emissions and toxicity are relevant for the results of the simulation.

The Suli simulation game is, so far, a prototype developed for testing the game concept.

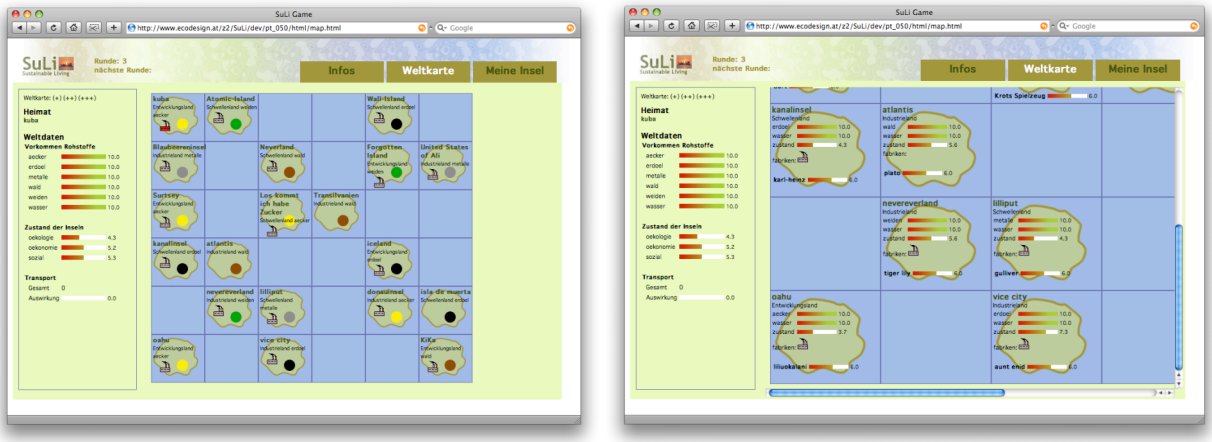

Figure 1: Islands on the Fictional Planet: Overview Showing Global Situation and Islands with Their Primary Resources (left) and Details Showing Situation on Every Island and Condition of Respective Avatar (right).

Figure 2: View for the Player: Data on Ecological, Social, and Economic Situation on Island; Condition of Avatar regarding Health, Wealth, Education, and Mental Balance; Marketplace, Inventory, and Waste; Developed Products and Actual Production in Factories (left) and Details for Numerous Design Parameters of a Specific Product (right)

3. Educational Framework

There are, so far, no comprehensive educational frameworks for the development of learning games, even if some tentative attempts have been made in recent years (Tennyson & Jorczak 2008). Any such frameworks, therefore, have to be developed from scratch based on considerations about content, target group, pedagogical goal and didactic principles. The content of the SuLi game is sustainable product design. This is a complex and ill-structured domain necessitating careful consideration of various alternatives. It is difficult to convey the knowledge important for such processes by traditional methods of teaching and learning. In addition, the target group are young students between 15 and 18 years of age attending secondary school. They might find traditional lecturing boring. The pedagogical goal is to raise the awareness for the question of sustainability, and not so much to teach the students a defined set of facts. Therefore, the decision to realize a course in sustainable product design for this target group as a simulation game seems to be advantageous. A simulation game supports exploratory learning (Bruner 1961), an approach that is adequate for the content domain and which supports the specific target group.

As mentioned above, increasing the motivation of the learners is one of the great advantages of learning games. We used Malone's (1980) concepts of challenge, fantasy, curiosity, control, and self-confidence. The challenge in the SuLi game consists of reaching the goal of the game. This goal cannot be reached easily and requires information about different aspects of the game (information about the state of one's own island but also about the SuLi game universe in general). SuLi is set in a fantastic environment (the islands of which the SuLi universe exists) and enables players to build up virtual contacts with the other players. Curiosity is stimulated in SuLi by the fact that the players need to know much about how the economy in this universe works to reach the goal of the game, e.g. that resources like oil will run out when used excessively by all players. Control is a very important aspect of computer games. In SuLi, it is, in principle, possible to reach the goal when the player has a good mental model of how the game works. This increases the sense of control and also the self-confidence of the players. In SuLi, the players immediately get feedback about their actions.

In an ongoing evaluation study, it will be tested whether this concept holds or has to be modified to fulfill the criteria described above.

4. Participatory Software Design and Evaluation

The success of any software and in particular of games where commitment plays a vital role has to be fostered to the greatest possible extent. User participation in the various design and development processes is a key concept here (cf. Yu & Liu 2006). Also, the actual achievements in trying to build better systems have to be evaluated carefully. We therefore apply different methods of user participation and evaluation in an alternating and iterative manner.

The prototype of SuLi will be evaluated in the course of the project in order to assess whether the game is understandable, playable and motivating for students. This information is important because only in this way we can be sure, whether it is appropriate to develop a full version of the game or not. Even if the game itself gets a positive response, an accompanying evaluation of the game concept makes sense, since weaknesses in the educational framework or usability problems can be solved at an early stage. The evaluation is based on the educational concept and basically tries to clarify whether it was possible to implement the concept. One of the great advantages of educational games should be that the students are highly motivated to deal with the content. In addition, they should learn relatively autonomously and develop their own perspective on the teaching material. The evaluation should assess whether this basic approach can be fulfilled by the game. Moreover, it will also be possible to identify problems in the game (e.g. whether the communication between participants works well).

First, the target group’s actual consumer behavior was investigated. Second, pre-implementation user tests of a paper prototype were carried out realizing the pedagogical concept (see section 3). Third, an executable prototype was implemented considering feedback of the users. Fourth, once more real users tested the prototype thoroughly with all its interactions (e.g. development, production, and trading of goods). The same group of users will later on participate in further development. And fifth, a final prototype will be played by an enlarged group of real users over a longer period of time. The following evaluation will show whether we have a proof of concept.

Methodologically, the evaluation of the game concept is based on two approaches: on the one hand, we will conduct focus groups with a class of pupils, on the other hand, we will use a short questionnaire on the Internet to reach all of the players of the final gameplay. Focus groups are a good method to get a first impression of the quality of an

implementation of software. They can also help to identify problem areas (see Kuniavsky 2003, p. 201). One of the advantages of focus groups is that given a adequate moderation participants can formulate very controversial opinions. Therefore, a spectrum of opinions can be better represented than with other methods of social science, because the participants in the debate are forced to develop their views in contrast to other opinions (see Gibbs 1997). Questionnaires are a problematic method in the evaluation of software, if only very general questions are asked, because usually they lead to uniform answers. In a very short questionnaire, only those questions will be used, that are concrete and enable pointedly different statements by the pupils (cf. Bortz & Döring 2006, p. 253ff). The focus groups will be held with a very small group of active students (the so-called core group, which is one class of Bernoulli high school). These pupils deal with the subject of the game intensively in various of their courses. The questionnaire will be sent to all students participating in the final gameplay.

4.1 Survey of Target Group's Consumer Behavior

For the implementation of relevant products in the game concept and the prototype, it is necessary to have valid knowledge about the consumer behavior of the target group. To investigate a large enough sample cost-effectively the evaluation method of questionnaire is a good choice (Bortz & Döring 2006, p. 252). The questionnaire must be large enough to cover the following complex issues. Besides typically purchased products from various divisions of goods (such as clothing, food or electronics) and the available financial resources, especially factors that have an influence on purchasing decisions are recorded (e.g. price, quality or regional production).

The developed questionnaire contained 19 questions (many included Likert scales or multiple choices). E.g. "How much money do you have every month?" "List 3 things for which you have spent most last month." "What were your three most recently purchased goods in the consumer electronics field?" "What is for you the most important purchase criterion for clothes?" "Through my consumer behavior, I can influence…"

43 female and 48 male pupils from senior classes of the Bernoulli high school were questioned about their consumer behavior. The average age was 16.4 years. Most adolescents have 20-50 € at their disposal every month from their parents. This money is used for food primarily. Also regarding the last purchased products food is naturally in leading position, but is closely followed by clothing. In the latter group t-shirts and jeans are top mentioned. The most important criteria when buying clothes, and electronic media are cost and quality. Last purchased beverages were by far iced tea, soft drinks and mineral water followed closely by beer. The most important criteria when buying beverages are taste and price. Preferred containers are here mainly disposable ones (non-glass) and reusable ones. Beer is predominantly consumed canned. Regarding foods burgers are the choice of the adolescents. Crucial factors when purchasing food are taste, price, and quality.

Referring to the results from the questionnaire we further consider the following consumer goods relevant for the learning game:

- Mandatory consumption: foods (i.e. burger, pizza, chocolate, fruit, cola, iced tea, mineral water, beer) and clothes (i.e. pants, t-shirt, skirt, jacket, shoes).
- Recommended consumption: living (washing machine, cooking stove, furniture, lighting) and hygiene (i.e. soap, shampoo) and communications (i.e. mobile phone, computer).
- Optional consumption: media (i.e. newspaper, TV) and entertainment (i.e. music player, event tickets) and sports (i.e. running shoes, sports dress).

3.2 Involvement of Target User Group

In the interests of research-education cooperation, a participatory development process with the active involvement of pupils is implemented. This process is divided into three phases:

1. The first phase is intended to review the basic game concept and the establishment of relevant factors in the target group for the image of the Life Cycle Thinking. These factors form the basis for the simulation model. In a first gameplay a paper based prototype was tested. At the end of this phase, there is a game concept with the most important factors of the simulation model and rules for the interaction process.
2. The second phase is the development of an executable prototype. Pupils will aid in the search for and elaboration of data for the chosen products. They will also act as consultants in the implementation of the game

prototype. By this means pupils will get insight into scientific work practice. This is also an interesting and very effective mediation of knowledge of sustainability.

3. In the last phase, a test run of the prototype will take place in the courses of the pupils. Beside the core group many other pupils will participate, who were not involved in the development process. The pupils from the development team act also as supportive tutors during this test phase.

6. Conclusions

Game Based Learning seems to be an interesting new possibility of teaching and learning, but the effort spent on designing games and the possible positive outcomes have to be weighed carefully. One of the major problems when designing learning games is that the goal of the game and the goal of the learning process might be contradictory. In the SuLi game, the most obvious goal of the game on a very superficial level is to sell as many products as possible. Following this goal can prevent pupils from increasing their awareness about sustainability. More effort is necessary to overcome this contradiction in the game by a careful design. The general approach in the design of the Suli game was a participatory one. Pupils from the target group are involved from the beginning and in every stage of the design process. We think that such an approach may help to overcome problems like the one mentioned above. In addition, the participatory approach helps to support the cooperation between research and education and acquaints teenagers with basic concepts of scientific work.

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