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“Green succeeds”: a simulation game for environmental education – development and evaluation

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1. Introduction and theoretical background

The simulation game “Green succeeds” (original title in German: “Grün geht vor”) was developed to make a contribution for the education in elementary school. The use of Gaming Simulation for environmental education is not a new idea (Bisters, 1997; Kriz & Rizzi, 2000). Well-known and widespread simulation games like “Fish Banks, Ltd”, a computer-aided simulation game, designed by Meadows, Fiddamann & Shannon (1993), already exist. “Fish banks” as a training tool and corresponding experimental studies show for example significant effects on the acquisition of systemic and social knowledge and on fostering sustainable decisions of the players (Kriz, Hettinger, Nerl & Gräsel, 2001). By using these types of ecological simulation games participants learn more about the sustainable development of systems. Additionally many of these games for environmental education support the training of social competencies as well (Ulrich, 1998).

However simulations and games for environmental education in elementary schools are mainly rather short and simple designed learning programs. On the one hand elementary schools are lacking of adequate simulation games, which visualize complex interdependencies in an appropriate pedagogical way. On the other hand there is a significant lack of scientific evaluation of these games to verify learning effects. The design of the simulation game “Green succeeds” and its evaluation should contribute to bridge these gaps.

The simulation picks up certain aspects of a commons-dilemma, originally called “The tragedy of the commons” (Hardin, 1968). The commons-dilemma is a specific type of a social dilemma: people are torn between maximizing their own immediate gain and maximizing the social and long-term gain (Liebrand & Messick, 1996). The feature that marks a commons-dilemma among other social dilemmas is the common pool, which in socio-ecological studies is represented by a renewable natural resource (e.g. a fish-ground). According to Ernst (1999) a major problem can be found in the structure of every commons-dilemma: time-delays, which are very common in complex systems but often not noticed by problem-solvers (Senge et al., 1994). People normally do not consider the long-term effects of their actions, often resulting in the collapse of the (eco-)system.

Knowing the people involved and knowing their intentions, is regarded as the substantial basis for mutual trust and cooperation in a social dilemma (Moore et. al., 1987). Referring to specific resource-dilemmas, Kramer & Goldmann (1995) confirm that cooperative values of the involved persons foster a more sustainable management than an individualistic or competitive disposition. The learning objectives of the game are therefore to foster environmental consciousness, to build up basic environmental knowledge, to teach the pupils basic principles of sustainability and systems thinking, to let them experience and understand effects of their decisions and typical feedback dynamics, and to support cooperation, trust and teamwork skills. The game was developed for the target group of pupils of primary school, aged 9 to 10.

2. Game description

The topic of the game "Green succeeds" is sustainable agriculture. The participants have to manage a farm as environmentally harmless as possible. In the beginning of the game, the class is divided into several small teams that consist of 4 to 6 pupils. These small teams represent farmer-families and are responsible for the management of a farm. All farms together form a village in an agricultural region.

Objectives like environmental consciousness, principles of sustainability and cooperation are included in the game. All farmers can interact in various ways with each other, share information and make decisions, related with sustainable agriculture. While managing the farm, each single farmer-family makes either environmentally harmless or harmful decisions, which have further effects on the common ecosystem. Like in a typical commons dilemma-game the individual farmer-families are affiliated with the others, through the common environment of the village. Decisions of a single farm effect not only the farm itself, but also all other farms and its families.

One part of the simulation game is a kind of board game. The simulation also contains some child-oriented elements like a "dream journey", which takes place before starting to play the game and a dance between the simulation rounds.

In every round of the game the families have to make a series of decisions to manage the farm. This is done by moving a pawn across the board. Every field on the board is combined with a specific decision, from different types of manuring to keeping animals. The pupils do always have the choice between two alternatives (one supports an ecological friendly, sustainable development, while the other is environmentally harmful). The decisions are made by choosing a decision-card, which has to be laid on specific fields of the board.



Figure 1: example of a game board

So-called "environmental indicators" give the individual "family" information how the environmental situation of their individual farm is (from green color = best environmental conditions to red color = a strongly damaged nature). At the same time an environmental indicator for the whole village shows the total condition of the whole environment. After every round the effects of the decisions that were made are analyzed and illustrated by shifting the indicator for every single farm. At the end of every round the village-indicator is shifting in regard of the farm-indicators. This leads to a reactive effect on the farm-indicators. Thereby the pupils can experience in which way individual decisions influence all farm-families. They also learn more about feedback loops as a central principle of systems thinking.



Figure 2: example of the "environmental indicator"

To help the pupils to make decisions, special dictionaries about ecological farming and sustainability are distributed to the farmers at the beginning of the game. The dictionaries include a legend for each term that is used in

the descriptions of the situations where decisions have to be made. They also help to gain of ecological knowledge.

It has to be said, that these descriptions are formulated in a neutral way, so that the pupils have to decide on their own if the decision is sustainable and environmental friendly or environmentally harmful. Of course it is the intention of the game that the whole environment and the environment of the individual farms are always as unencumbered as possible. To accomplish this goal is often difficult for the "families", because unforeseeable ecologically harmful events might surprise the players. These events shall represent real problem situations. Those situations make the pupils feel affected and offer the possibility to get connected with the main topic of the game. The facilitators bring in these events, depending on specific situations (e.g. the lake of the village is no longer in ecological balance). On the one hand these events offer more thrilling-elements within the game and on the other hand further environmental relevant interdependencies from every-day life can be experienced.

After such an ecologically harmful event a television-show takes place about this topic. Here representatives of the game families, members of the so called "farmers-association", talk about the critical situation after the event. They discuss together how the situation can be improved again. So the coverage of the events has also an effect on the cooperation between the groups.

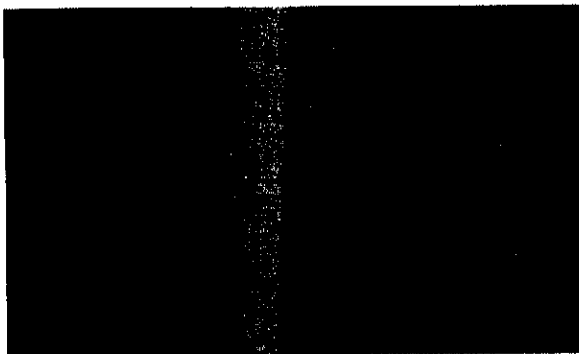


Figure 3: example of the dictionary

The simulation game consists of different phases. Before the game starts, the pupils perform a relaxing exercise and they listen to a story. This story is called "dream journey". It is a kind of taught meditation in which the children are transferred to an idyllic and intact environment. The story also offers a way for motivating the pupils to participate in the game. After this "dream journey" the children are able to concentrate well and to understand the briefing better. The simulation game itself is played for about one and a half hours. In addition a certain "farmers-dance" is performed again and again in the course of the game. For the children this dance means change, fun and motivation. Without this motivation learning with the game would not be possible (Bu-

land, 1995). A final debriefing follows after the game phase. The debriefing offers the opportunity to reflect on the game and the decisions that were made. It also helps to reach the learning objectives. Processes and methods of the debriefing are tailored to the target group. In its center stands the repeated refurbishment of the decisions, which offers the opportunity to talk about the correct reasons for the effects on the environment. On the other hand the group dynamics can be discussed and the individual feelings of the participants can be expressed. Also the reference to ecological farming in reality is made. The debriefing changes between large group activities and reflection in the small "families". Particularly expressive methods, writing discussion, feelings-indicators, written learning diary etc. are used.

3. The learning environment of the game

Commons dilemma situations include very often environmentally harmful results. Very often these situations can only be solved by cooperation between the participants. Therefore it is fundamental to assume that an environment conscious behavior is implemented primarily by corresponding social and cooperative abilities (Fuhrer & Wölfing, 1997; Ernst, 1997; Mosler & Gutscher, 1997; Salehian, 1995). It is a known advantage of the gaming simulation approach that games promote acquisition of knowledge, change attitudes and foster social competencies of the players. Therefore gaming simulations are ideal for environmental education. "Green succeeds" supports cooperative and social behavior. The structure of the game also represents a learning environment for team skills. The children must manage "their" farm in small groups, with the aim of doing this together and as ecological as possible. Already at this point it should be obvious that this organization form corresponds to cooperative learning settings. To be as successful as possible, the players have to cooperate with each other in making decisions in the small farmer-teams and communicate in the farmers' association. Debriefing plays another essential role for the training and the promotion of cooperative and social competencies. Most important point for the debriefing is the interaction process within and between the farmer-groups. This leads to a positive effect on the social relations, on the group/class climate and on the empathy ability of the group members as well as on the individual development of social behaviors and conversation skills.

Additionally, the cooperative learning form of the simulation game does not only have direct positive effects on the teamwork skills but also promotes the environmental consciousness and the acquisition of ecological knowledge as well. An environment-conscious attitude is not enough for acting sustainable with the environment in reality but it forms nevertheless an important precondition for sustainable systems management (Diekmann & Preisendörfer, 1992; Kaiser & Fuhrer, 2000). Within the farm groups and the whole community of the village a collective identity arises, which produces a strong feeling of belonging to a community and a feeling of common responsibility for the shared environment. This can be the starting point for

a joint problem consciousness which in turn leads to a more lasting environment conscious attitude and to sustainable management decisions (Mosler & Gutscher, 1996).

"Green succeeds" promotes the acquisition of ecological knowledge. The offered knowledge (for example in the dictionaries) is discussed during the game jointly in the farm groups and in the farmers' association meetings. The pupils connect and elaborate their new knowledge with their pre-knowledge and are stimulated to replace and to enlarge their already existing mental models. Furthermore the discussion of the contents in the groups leads to inter-individual controversies, which arouse intra-individual cognitive conflicts. In this way further cognitive processes of higher order are initiated (Huber, 1987; Slavin, 1993). The social cohesion and interdependencies which are developing in the whole group causes increase motivation and efforts to understand the contents of the game while discussing and acquiring the knowledge in play and debriefing (Oudenhoven, 1993).

4. Evaluation

The evaluation of the game "Green succeeds" was focused on three areas: to analyze the acceptance of the game, the learning process (motivation) and the learning effects.

Hypotheses have been that the simulation game should cause

- a high acceptance,
- a high motivation,
- an acquisition of environmental knowledge
- a fostering of environmental consciousness
- a support of teamwork skills

4.1. Method

The acceptance, motivation and the fostering of teamwork skills and attitude towards cooperation were estimated by the participants after the game using a questionnaire. The change of the environmental knowledge and of the environmental awareness of the participants was analyzed by using questionnaire and knowledge-test before and after the game.

In the knowledge test the pupils were asked 8 questions about "ecological farming". In the multiple choice test the pupils had to mark the two correct answers out of a sample of four answer alternatives for each question (maximum 16 correct answers). The items of the questionnaires are statements in order to measure motivation, acceptance, teamwork and ecological awareness. The pupils gave their agreement to the statements using a Likert assessment scale (1 to 5; 1 = "Yes exactly!" [corresponds with a total consent] to 5 = "No, not at all!" [corresponds with total rejection]).

The different aspects of the simulation game (for example: How did you like the dream journey?, How have you understood the environmental indica-

tors?, How did you like the farmers association? etc.). were judged by the pupils using the "assessment indicator method". The pupils answered these questions with sticking points to a big flip chart seize scale from "Not at all!" (corresponds to the lower end of the indicator) to "very good" (upper end). These indicators were not only used for the evaluation, but also as part of the debriefing.

In addition the teachers of the three classes (who observed the games) were interviewed about their impressions and estimated learning effects and learning process.

The simulation game was carried out with 3 fourth grade elementary school classes from Munich. The sample contained altogether 73 pupils at the age of 9 or 10 years (class 1 N=26; class 2 N=27, class 3 N=20). The simulation game was played at the beginning of a school-day. The game lasted for two and a half hours including the debriefing and a short break.

4.2. Results

Acceptance and learning process

The personal assessment of the simulation game was carried out with a questionnaire consisting of 12 items (about the motivation of the pupils during the game, acceptance of the simulation game, cooperation and teamwork in the game and the estimation of the subjective learning profit). The reply to these 12 items suggests that the simulation game was felt and judged by the pupils as very positive: The mean of the complete sample (N=73) and over items is $M=1.41$ with a standard deviation $SD=0.43$; 95.9% of the pupils put their cross at 2 or 1 on the assessment scale, expressing in this way their positive or very positive acceptance of the method, their high or very high motivation and estimation of a high or very high personal learning success. The pupils have also experienced a high degree of cooperation and teamwork in the simulation game. In addition the results of the indicator-method and the interviews with the teachers showed a high acceptance of all of the different game elements.

Knowledge acquisition

The environmental knowledge was tested before and after the game. With the data of all three classes an analysis of variance was carried out showing a highly significant increase of knowledge. It turned out on the one hand that all three classes are significantly different in their knowledge before and after the game (classes; $F= 4.25$; $df= 2$; $p< .016$), on the other hand all classes (and pupils) performed significantly better in the knowledge test after the game (pre-test and post-test; $F= 8.18$; $df= 1$; $p< .005$). Furthermore it could be shown that there is no significant interaction effect of class and date ($F= .92$; $df= 2$; $p< .40$). The results of the knowledge check and the differences of the three classes are illustrated in the following diagram (Figure 4.). Higher

values on the scale "environmental knowledge" mean more correct answers in the knowledge tests (maximum 16 correct answers).

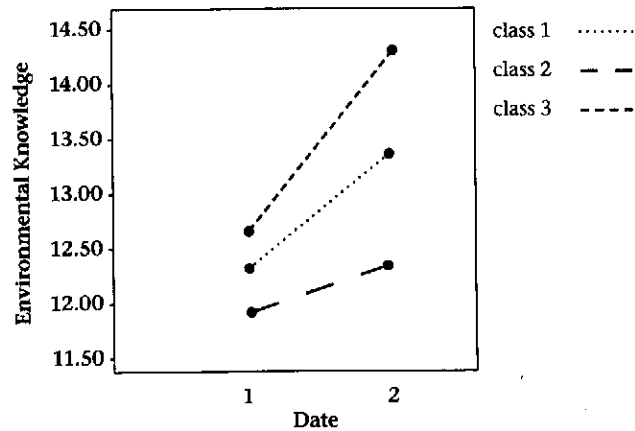


Figure 4: results of the knowledge test of the three classes before and after the game (date 1 and 2).

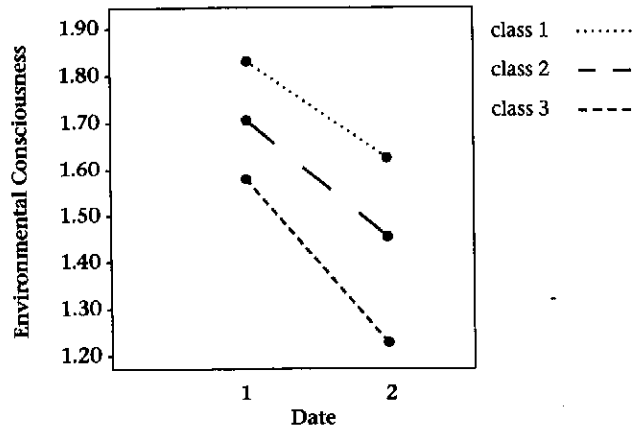


Figure 5: results of the questionnaire about environmental awareness of the three classes before and after the game (date 1 and 2).

Another analysis of variance was calculated to test the change of the pupils in their environmental awareness. All three classes (and pupils) showed a significantly increased environmental consciousness after the game compared with the results of the pre-game awareness ($F= 9.30$, $df= 1$, $p \leq .003$). Again the three classes are significantly different ($F= 3.44$, $df= 2$, $p \leq .035$) and there is no significant interaction between date and class ($F= .260$, $df= 2$, $p \leq .77$). The diagram (figure 5) shows the increase of the environment conscious attitude. Note: A low mean on a scale of 1 to 5 corresponds with a high awareness (1= maximum of environmental consciousness to 5= minimum of environmental awareness)!

5. Conclusion

Summarizing the results it can be concluded that participating in the game leads to a significant improvement of the pupils' ecological awareness and to a significant increase of the ecological knowledge. In addition, the game enabled the pupils to prove their teamwork skills. Finally the main results of this study point out that the game "Green Succeeds" is an adequate instrument for environmental education in elementary school. The simulation adopts the complex situation of a commons dilemma and puts it in a motivating and suitable game about sustainable agriculture. The learning environment with its playful and debriefing elements fits perfectly with the age of the target group. With this project not only a new game for environmental education was designed, furthermore we showed results from a first study in three classes that prove clear learning effects. It must be admitted that this study only concentrated on short term outcomes, the research about long term learning effects and outcomes will be conducted in follow up studies.

Note

The simulation game was designed by Michaela Schmitt, Stefanie Thomé and Kathrin Ziegler in a Workshop about game design at Ludwig Maximilians University Munich, led by Willy Christian Kriz in 2003. The evaluation was carried out 2003/2004 as a part of the diploma thesis of Stefanie Thomé and Kathrin Ziegler.

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Researching Congruency in Facilitation Styles

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1. Introduction

Our experiences and research in the use of simulations and games for learning suggest that a complex web of factors informs the choices and decisions made by an educator when selecting and implementing a learning mode. Such decision points occur several times - the most important ones being:

- General decisions about preferred forms of learning methodology (lecture, experiential learning, simulation, etc)
- The appropriate form for a specific occasion
- The manner of presentation (face to face, online, role play, simulation etc)
- The preferred 'style' of performance as facilitator/teacher etc
- Manner of managing the process - once it has begun
- The approach to debriefing - transforming the nature of the experience into the naming of learning outcomes
- Assessing the learning - as named, *and* as experienced

Some of these are more often tacit/implicit decisions rather than conscious and informed ones. They are predicated as much on personal inclination and prior success as on the intended goals for learning/teaching process being designed.

While the literature has something to say about each of these points (Boud & Griffin, 1987; Boud & Miller, 1996; Brookfield, 1995; Heron, 1999) there is comparatively little supporting theoretical work to help individual educators gain insight into how their personal characteristics and philosophical stances inform and shape the nature of their on-going decision making processes.

2. Understanding the Forces in a Simulation

This paper continues our earlier work (Leigh, 2003; Leigh & Spindler, 1998, 2004) on the role of the facilitator in simulations and games for learning. In this paper we are exploring ways of identifying personal preferences and seeking to understand the manner in which they are likely to impact on - and shape the enacted styles of - educators as they choose specific learning environments. Of course, our interests centre on those educators choosing to use simulations and games. These usually generate a greater complexity of forces in a learning context where the facilitator has - for a time - relinquished control over participants' actions and therefore may also put aside any claims to 'authority' as an identifier of learning gained from the experience.