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Games and Gamification – New Instruments for Communicating Sustainability

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Abstract

Sustainability is not a single concept, but a bundle of concepts that has broadened significantly in recent decades. Education for Sustainable Development (ESD) must therefore not only impart new knowledge but should also focus on supporting its students in acquiring new competences, both on a personal and an institutional level. Games and gamification can be important instruments for developing these competencies and experimenting in very different situations, simulating different scenarios and experiencing unexpected situations and outcomes.

The term “gamification” refers to the application of game-design elements and game principles in non-game contexts. In the context of this paper we will investigate in applying games or game elements for communicating sustainability, which includes actual games with a sustainability theme as well as giving tasks and activities for sustainability communication as gamified motivation. In general, by integrating these playful elements, a complex topic such as sustainability can be brought closer to people. For sustainability issues, this method can thus significantly support the communication of important topics to the general public.

In this paper, two variations on the application of game elements in sustainability communication are presented. In the first example, a board game and a computer simulation as an experimental platform was created within the Sparkling Science project “Game of Clones” where a team of scientists together with high school students explore the spreading behaviour of the invasive species Japanese knotweed. The second example revolves around “Regionale Spirale”, a game dealing with economic associations. Here, the players try to work together against a downtrend in their region by making good agreements to act both for the benefit of the region and in their own interest.

These examples show that participative games can help us to illustrate the complexity of decisions and their consequences and thus create awareness about sustainability issues. Gamification can also reach people on a non-scientific level who would not have been attracted by pure content and facts. The biggest learning of these implementations was that a strong part of the learning process takes place during the development of the games and their rules. With knowledge of the opportunities and limitations of gamification, it can be a powerful tool for sustainability communication.

1. *Sustainability – from concept to movement*

Human societies have always changed or tried to change their environment. Depending on the state of the art and the means available, this has been more or less successful. Economic growth has been the mantra in most countries and the answer to a lot of crises. As Yuval Noah Harari states in his work *Sapiens: A Brief History of Humankind (2014)*: “The most common reaction of the human mind to achievement is not satisfaction but craving for more.” With the increasing use of fossil raw materials and fuels in the 20th century, the finiteness of certain resources became visible. In the 60s and 70s, people began to realise that the growth over the past several centuries has led to the waste of resources, environmental pollution, dying forests and a population explosion. At this point, the Club of Rome spread its message about the "Limits of Growth" (Meadows et al., 1972). The scientists around Denis Meadows postulated with several simulations that an absolute growth limit would be reached within 100 years. The authors assumed that exponential growth would require more and more resources, which would irreparably damage the environment. As soon as this limit is reached, humankind must prepare for a rapid and massive decline in population and industry. The book stands for the environmental turnaround of the 1970s, and its title in particular has "inscribed itself in collective memory" (Kupper 2011: 1). The idea of finite growth and resources found its way into the political and general discourse. The concept of sustainability, however, originated much earlier.

In the German-speaking world, the *concept of sustainability* (not the term) can be traced back to the Middle Ages. Early forest and pasture regulations in the Alpine region laid down rules that permit and facilitate the long-term use of the land and the corresponding resources. These considerations were initially based on the demand: everyone should use a resource only to the extent they needed it. Later, the focus was also placed on the availability of the resources. As can be read in a decree on the use of the Vienna Bürgerspital Forest by Rudolf IV of 1359, the regenerative capacity of the forest stands was also considered in the regulations (Sonnlechner 2010).

Grober (2010) traces the changing cultural history of the term sustainability. Other authors (Grunwald & Kopfmüller 2012, Jungmeier et al. 2017, Krainer & Heintel 2014) also point out that the term is subject to a constant change in meaning. The *term sustainability* goes back to Hans Carl von Carlowitz, a German tax accountant and mining administrator who observed that mining and smelting had decimated forest resources in Europe and how the availability of timber had increasingly become a limiting factor. With the book on “Sylvicultura Oeconomica” (Carlowitz 1713), he presented his ideas for sustainable forest management and, with a focus on long-term yields, attached an economic dimension to sustainability. The limited resilience of social systems also plays a role and leads to the three-pillar model of sustainability. As a result, sustainability has an economic, an ecological and a social dimension that are interdependent.

The Sustainable Development Goals (2015-2030) by the United Nations are a good example that demonstrates that sustainability plays a role in almost all areas of life. The 17 goals, which are specified in 169 targets, also include "developed" countries and address the issue of education to a large extent. Target 7 of Goal 4 "Quality Education" explicitly requires that “by 2030 all learners acquire the knowledge and skills they need to promote sustainable development, including through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and culture's contribution to sustainable development.” Of course, education is also essential in order to pursue most of the other goals in a sustainable manner. The SDGs replace the eight Millennium Development Goals (2000-2015), the second of which was to achieve universal primary education. The main difference to the SDGs is that this goal focused on quantity (e.g., high enrolment rates) only to see the quality of education decline in many societies. The SDGs represent the first attempt by the world

community to focus on the quality of education – of learning – and the role of education in achieving a more humane world.

What education in sustainable development and individual engagement can achieve has been demonstrated by a Swedish girl named Greta Thunberg who, in August 2018, stood in front of the Riksdag with the sign “Skolstrejk för klimatet” (school strike for the climate) every day for three weeks during school time (Gessen 2018). What followed then is called the Greta Thunberg Effect. After the Swedish general elections, Thunberg continued to strike on Fridays, quickly gaining worldwide attention. She inspired school students across the globe to take part in student strikes to raise climate awareness. As of December 2018, more than 20,000 students had held strikes called "Fridays for Future" in at least 270 cities (Carrington 2018). She answers critics with: “Some people say that I should study to become a climate scientist so that I can ‘solve the climate crisis’. But the climate crisis has already been solved. We already have all the facts and solutions. All we have to do is to wake up and change.” In February 2019, in response to Thunberg's efforts, EU leader Jean-Claude Juncker presented a proposal to spend hundreds of billions of euros on climate change by 2021 (Roth 2019). Climate issues also played an important role in the European elections in May 2019 (Huggler 2019), Europe's Greens, amid rising public concern about the climate crisis, recorded their highest ever score in the European parliament, winning 75 seats (europarl, 2019). In June 2019, Swedish Rail reported that the number of Swedes using the train for domestic journeys had increased by 8% compared to the previous year, reflecting growing public concern about the impact of flying on CO_2 emissions, as evidenced by Thunberg's refusal to participate in international conferences. Being embarrassed or ashamed to take an airplane because of its environmental impact has been described in social media as "Flygskam" (“Flight shame”), along with the hashtag #jagstannarpåmarken, which translates as #istayontheground (Henley 2019).

2. *The concept of gamification in education for sustainable development*

As can be seen from the opening chapter, sustainability is not *one* concept, but rather a bundle of concepts that has undergone significant changes over recent decades (see Figure 1). The concept of sustainability has become more complex, leading from the concepts of economic sustainability of the 19th century to the integration of ecological and social sustainability. The global Sustainable Development Goals additionally focus strongly on different aspects of justice, bringing a new dimension to the discussion.

These ethical aspects even go beyond the scientific system and thus challenge societies and their educational systems. Education for Sustainable Development (ESD) must therefore not only impart new knowledge but should rather focus on supporting its students in acquiring new competences, both on a personal and an institutional level. It is necessary to remain able to act in changing environments, faced with complexity, uncertainties and ambiguities. Games and gamification can be important instruments for developing these competences and experimenting in very different situations, simulating different scenarios and experiencing unexpected outcomes.

According to the ecological dominance-social competition (EDSC) model (Flinn 2005), parts of the human psyche have evolved to compete with other individuals. Therefore, it is not surprising that people like to carry out activities in which they can compete with others. For a long time, such competition has mainly been known in games or sporting competitions, but this motivational mechanism is now increasingly being used in other contexts as well. In addition to competition, there are other mechanisms in games that increase motivation to participate. The use of these mechanisms is at the core of gamification. Gamification is therefore a way to achieve this increase in motivation in non-game contexts, such as in knowledge management. Konstantin Mitgutsch, MIT researcher, and

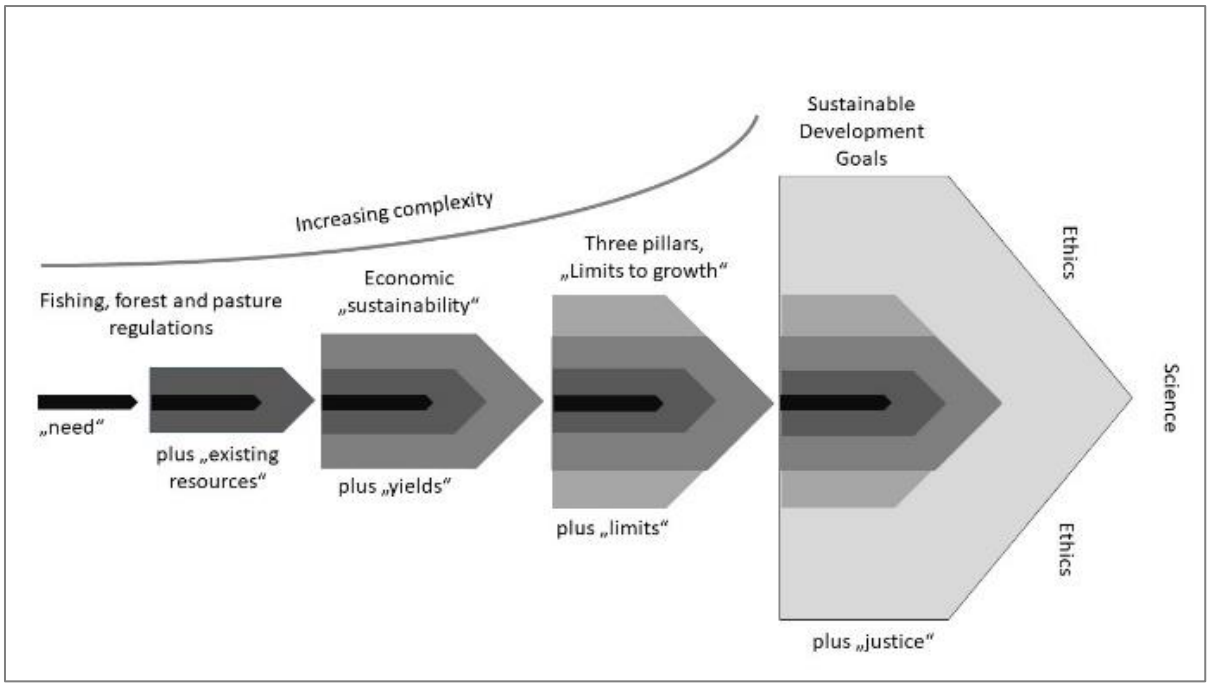

Figure 1: SDGs as an ethical concept (Borsdorf et al., in prep.).

Kai Erenli, lawyer and game designer, have another explanation as to why this method is so successful: "People all belong to the genus *Homo ludens*, we are only taught to forget that." (Bauer 2019). *Homo ludens* is an explanatory model according to which humans develop their cultural abilities primarily through play. The game makes it possible to experience the constraints of the outer world and to transcend them at the same time. While the term gamification became fashionable a few years ago, the possibilities offered by the concept have now gained a foothold in the working world. Many playful elements have found their way into our everyday lives and prove to be successful.

Gamification as a term originated in the digital media industry. The first documented usage dates to 2008, but gamification only entered widespread adoption in the second half of 2010, when several industry players and conferences popularised it (McGonical 2011). Since it is still a very young field, there are many different interpretations of the concept. The following selection of definitions demonstrates the broadness of the term gamification:

- "The use of game design elements in non-game contexts" (Deterding et al. 2011)
- "The use of features and concepts (e.g. points, levels, leader boards) from games in non-game environments, such as websites and applications, in order to attract users to engage with the product" (Macmillan Dictionary 2019)
- "Using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (Kapp, 2012)

What these definitions have in common is that gamification is not aimed at pure entertainment and is used in a context that is rather untypical for games. Often the goal is to motivate users or to teach them something.

In many cases, gamification overlaps with the concepts "serious games" and "edutainment". *Serious games* are games or game-like applications that are developed with technologies and design from the entertainment software sector and do not primarily or exclusively serve entertainment (Marr 2010). The learning of new skills and competences is a central component in a serious game. In addition, learning content and learning tasks are integrated into the game world. The intention is to teach and train new skills in a playful way. (Lampert et al. 2009). *Edutainment* is an artificial word consisting of education and entertainment (Pohlmann et al. 2005). In contrast to serious games, edutainment,

which is also called "game-based learning", focuses on the pure transfer of knowledge. The game part is only used as a reward after learning. Learning is thus combined with entertaining elements, which is used, for example, in interactive language courses.

In a scientific context, such as sustainability communication, these tools can be helpful in maintaining people's interest by simplifying and loosening up complex or difficult topics. Finding solutions and knowledge yourself can also help to anchor knowledge permanently.

2.1. Gamification in environmental education in the past years

Modified types of gamification have long existed in environmental education. Especially playful and interactive elements in exhibitions and interpretive trails are common practice. As the Chinese Confucian philosopher Xunzi (312-230 B.C.) wrote in his work Ruxiao (The Teachings of the Ru): “Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand.” Interactive installations and elements actively involve visitors in the communication of information and thus encourage them to act. In contrast to an information board, interactive elements take visitors out of the passive role of "just reading" and anchor what they have read in their memory (Arnberger et al., 2007). Experiencing nature through emotional and sensory activities is a part of environmental education that is inextricably linked with the name Joseph Cornell. Since the 1970s, the US American nature pedagogue has presented methods in books and worldwide lecture tours that enable people, especially children, to experience nature as impressively and instructively as possible (Cornell, 1979). In 1991, in his book “*Sharing the Joy of Nature*”, he described a progressive concept for the systematic development of experience walks, the “flow learning concept”. The methods contained therein, often subsumed under the title "Nature Experience Games", are now an elementary component of nature education programmes and are also increasingly being used in interpretive trail concepts. In the following passages, four individual interactive elements of past projects will be presented.

The Centre of the Hohe Tauern National Park in Mallnitz, Austria, has been a meeting point for visitors for many years to learn more about the National Park and its special features. In 2018 the exhibition “univerzoom” was opened which accommodates many interactive elements. Spread over 6 rooms including three workshop rooms for visitor care, there are stations that inform and involve the visitors and stimulate their senses with a balanced mix of informative and interactive elements. At one station, presented as a quiz, tree species have to be identified by touching different wood logs (Figure 2). Children and adults can test and challenge each other with closed eyes and then learn about the species. By touching and feeling the wood, the facts about the species become more accessible to the visitor.

Figure 2: Tree Quiz at the "Univerzoom" Exhibition, Hohe Tauern National Park (Peter Brandstaetter)


Figure 3: Folding panels on the subject of “wolves” in the exhibition in the Nockberge Biosphere Reserve (E.C.O/Bachlechner)

The redesign of the visitor facilities along the Nockalm Road includes a new exhibition in the Pfandlhütte cottage around the theme “Wildlife - Landscape – Habitat”. The subject of “wolves” is presented using a variant of the classic folding panel (Figure 3): The upper sides include questions such as "Is it a problem when wolves eat red and roe deer?”, "Will I see a wolf in the Nockberge mountains?" and "Are wolves dangerous to humans?", and by folding up the panel the correct answer becomes visible. Visitors can learn at their own pace and discuss the topic with one

another. This type of installation can be especially helpful for critical topics such as the return of the wolf.

The Pöllauer Tal Nature Park is characterised by large populations of the old Styrian pear variety “Hirschbirne”. Successful networking of regional actors together with exemplary marketing in the region has cultivated great demand for the regional Hirschbirn’ products (such as juice, brandy, vinegar or dried pears). An interpretive trail conceived in 2017 leads visitors along the fruit trees, past the local farmers and fruit presses to regional marketers. One station, for example, shows the visitors which and how many regional products are used by farmers to produce a quantity of vinegar (Figure 4). Children and adults can rotate the various vessels and try to guess their contents.

Figure 4: Turning and sliding elements on the subject of regional products at the Hirschbirn Trail, Pöllauer Tal Nature Park (E.C.O./Jungmeier)

The interactive elements can be diverse and creative, and do not always have to be classical installations such as folding panels. Experience reports from the exhibitions and interpretive trails have shown that children and adults alike become highly motivated when they are allowed to participate. Such interactive elements often awaken animated discussions and exchanges at stations that result in a variety of educational outcomes.

3. Practical implementation of gamification

The following two practical examples show possible variants of gamification in a scientific context. Both are concerned with the transfer of complex facts into analogue (board) games.

3.1. Game of Clones – When finding a strategy becomes a game

Fallopia japonica as an invasive alien species to Europe and North America presents a significant problem to the existing flora as well as to infrastructure and agricultural land. As a result, measures and attempts to control the plant are increasing rapidly. However, conservationists are not yet able to agree on the most suitable method. Subsequently, a team of scientists and high school students are making this the focus of their research project ‘*Game of Clones’.* The aim of the Sparkling Science project, which runs from 2016 to 2019, is to investigate spatial models of the spreading behaviour of knotweed under different conditions. To pursue this goal, a vast understanding of knotweed, especially regarding its ecological optima, its dispersal strategy and its response to different control measures is necessary. For answering some of the open questions, experiments will be used. The research team excavated rhizomes to gain knowledge about the rhizome growth (see Figure 6), collected DNA samples to obtain information about its hybridisation (Figure 5) and applied various control measures to test the plant’s ability to regenerate. The outcomes of this project have led to the creation of a board game and a computer simulation model based on a cellular automaton that allows the spreading behaviour of knotweed to be analysed in an interactive manner.

The board game '*Game of Clones'* (Pichler-Koban 2019) was created for both children from the age of 10 and adults. The project team has gathered feedback on a game prototype by having different play testers, including adults and children, playing the game on a prototype consisting of a large printed game map with paper cards and plant LEGO™ models. By adding and removing sections of the LEGO plants, growth and the success of control methods may be visualised (Figure 7). The cooperative strategy game requires players to work together as teammates against a single 'opponent', Japanese knotweed. The game starts with a landscape of various suitable habitats for knotweed, occupied by a small number of randomly distributed *Fallopia* clones. The players all start in the same town and will move around the board to apply different measures to eradicate the clones and to keep particularly valuable areas clear from the weed, all while using resources as efficiently as possible. Very quickly the number of plant clones begins to rapidly increase, mirroring the plant's rampant growth habits. The mechanics of the game are based on event and action cards. Each round starts with an event card, which affects Japanese knotweed growth based on the narrative of different environmental conditions. Based on this, the knotweed then spreads in a specific way and a certain speed. Then, it is the player's turn who can choose between moving around and/or playing action cards based on state-of-the-art control methods such as mowing, manual eradication, sheep grazing, glyphosate, weed control fabric or biological control (*Aphalara itadori*). When designing the game, it was also a goal to match effectiveness of the control strategies with their real-life counterparts, while keeping the game balanced. For example, one card defines a manual rooting of a plant, which is a cumbersome and less effective strategy in real life, although it is applied at times. In the game the card has a use when a single plant has to be eliminated on the board. Depending on the strategy and the players' communication and cooperation, a combination of measures can lead to success, i.e. reducing or stopping the plant's growth. The players win if they manage to displace all plants from the game plan and lose if one of the nature conservation areas is invaded by a complete clone of knotweed.

Figure 6: Measuring the rhizome length growth (E.C.O./Fuchs)

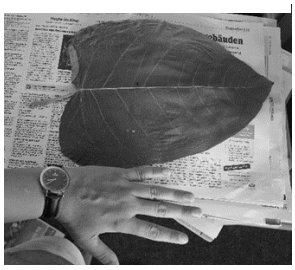

Figure 5: DNA Barcoding of *Fallopia* clones. Pictured here is *Fallopia sachalinensis*, the bigger relative from Russia (E.C.O./Fuchs)

Like many board games, Game of Clones is a round-based board game without a strict time limit for a move. While the gameplay itself invites the next player to make his or her move individually in the battle against the plant, it is also possible to carefully ponder strategy in discussion with the other players. This is particularly apparent in group settings where the best performances emerge from players collectively developing a sequence of moves. In several test rounds, we could see that the players started to realise how fast Japanese knotweed can spread and how little can be done about it, if it is not managed effectively early on. The only way is to cooperate, to combine control measures and to act as quickly as possible. Whenever the population is small, it is still quite easy to manually remove the plants one by one, once the board is mostly overgrown by knotweed, it is extremely hard to push back the plant. The game is designed to be close to reality and in terms of controlling knotweed, it shows that mechanical methods are time-

Figure 7: The board game "Game of Clones" in its development phase (E.C.O./Jungmeier)

consuming and inefficient, and that poison and weed control fabric are more efficient but are expensive in terms of long-term consequences. Thus, Game of Clones creates awareness of invasive species and possible strategies against them in a playful way. Besides that, the students from the research team were able to take home a lot in the process. By being able to participate in the experiments and the development of the board game, they learned a lot about invasive alien species and simultaneously enjoyed the feeling that they were making an important contribution to science.

The board game can also be backed up with real aerial photographs. This way, experts and affected parties (e.g. actors from nature conservation, administration, agriculture, construction site management) can develop solutions in a workshop for areas where the occurrence and spread of Japanese knotweed is seen as problematic. In doing so, they also get to know the interests and problems of the other participants and can negotiate their positions away from a real conflict. In the best-case scenario, a common "Fallopia strategy" is available at the end of the workshop day.

The electronic version of the game, currently in development, while losing the tactile aspects, does offer several advantages making it an appealing option for exploring the topic of Japanese knotweed:

- Firstly, it frees players from managing game state, in particular manipulating the plants as they grow. In the board game it is necessary to add parts to a lot of plants in a growth phase, which is cumbersome, especially in phases with a lot of plants on the board. While many players, particularly children, enjoy this task (see also Xu (2011) on this topic), it is undoubtedly one of the more error prone and time-consuming aspects of the game. Thus, the electronic version of the game may be played significantly faster than a short game (Elmenreich 2019).
- Secondly the electronic format of the game offers the opportunity to link in additional information in a variety of formats as the game it played, strengthening its educational value. Consider, for instance, if a player is contemplating spraying an area to control a plant, web links could include further information about real herbicides, how they work and what their potential long-term effects are.
- Thirdly, it is able to reach a much wider audience with lower overheads. By being playable in a browser on a desktop computer or a tablet, the game can be experienced without the necessity of purchasing the physical medium regardless of geographical location.
- Fourthly, the game may be easily saved or recommenced at any time.
- Finally, the electronic version offers increased variety compared to a traditional board game. The landscape, such as the size of the board, the vegetation and soil types, the number of initial clones and the number of protected area as well as the number and position of cities, may be changed freely to reflect the players' skill levels.

Overall, while not being as accurate as a simulation, the sense of attachment to the world of Game of Clones invites experimentation together with a healthy desire to win, making it a fun way to learn about a complex topic.

While the board game was designed with rules that favour playability, the computer simulation of knotweed spread[1], is a more realistic approach to the theme and specially developed for decision-makers. Although it is not a game, it still allows users to "play" with the system in order to learn about outcomes of different strategies. The simulation is implemented in Netlogo (Wilemsky 1999), a simulation language supporting easy visualisation of spatial processes. It uses a cellular automaton model, which is a simulation method for studying complex systems by modelling the world as a discrete grid (a lattice) where each grid cell is in a defined state that is updated in a simulation step (Elmenreich

[1] NetLogo simulation model of Knotweed Spread available at https://sulfurous.aau.at/~wilfried/goc/GameofClones_v5.nlogo

2009). The simulation grid can be underlaid with satellite images of affected areas, which makes it an important decision-making tool for protected areas. If the users fill the database with the most important data on current vegetation and site conditions, they can play through various scenarios and thus decide on a suitable combination of control measures.

The Netlogo computer simulation model is available as open source, which allows students to contribute in the programming. Thus, the students as one target group simultaneously function as developers and as an important reference group regarding its user-friendliness and functionality.

3.2. "Regionale Spirale" – A game on economic associations

Figure 8: Prototype of the game "Regionale Spirale" (E.C.O./Jungmeier)

Peripheral regions around the world are facing major socio-economic challenges (Kapeller 2017). The inhabitants of such regions often see themselves as the losers in globalisation. The reasons why a region looks as it does are usually thought to lie outside the region: large corporations settling elsewhere and dictating the "rules of the game", bureaucrats in Brussels, Vienna and other major cities who do not know the problems experienced within villages and instead regulate the curvature of cucumbers and protect tiny beetles. The inhabitants of peripheral regions rarely perceive themselves as actors who could influence and shape the development of the region.

The situation in a part of Central Carinthia is quite similar. It is located in Austria's southernmost province of Carinthia and includes 32 communities with around 100,000 inhabitants, spread across the three political administrative districts of St. Veit, Feldkirchen and Klagenfurt-Land. In contrast to comparable regions, however, an active group of people (entrepreneurs, farmers and private individuals) try not to limit themselves to externalising the problems that arise, but to take the initiative themselves believing that the people of the region should develop an awareness that their actions and decisions influence the development of the region. The Kärntner Wirtschaftsförderungs Fond (Carinthian Economic Association) would like to support them in consciously assuming responsibility.

In order to be able to counteract the rather negative development trends in the region (declining population as well as a lack of employment opportunities, care and support facilities), it is first necessary to understand the mechanisms that work in this development. It is also important to highlight the role that one's own decisions have in influencing development.

The educational game presented in this section intends to promote this awareness by making the complex structure of a region with its different actors and their often very different goals transparent to the players. Christina Pichler-Koban, Michael Jungmeier (E.C.O. Institute of Ecology) and Wilfried Elmenreich (Institute of Networked and Embedded Systems, Alpen-Adria-Universität Klagenfurt) designed the prototype – the "Regionale Spirale", a table top game (Figure 8). The players try to work together against the downtrend in the region and by making good agreements to act both for the benefit of the region and in their own interest. During each turn the players must decide anew: should they invest in community and region, or should they act primarily for their own benefit? In the end, you can only win if you do not lose sight of either of the two goals and if you know how to reach agreements with your fellow players. If the distance between the individual players becomes too great, living together no longer works so well. The players lagging behind also burden those who are actually close to the goal.

The game is based on the assumption that the interaction between players in a region reinforces both positive and negative trends. For example, if a region lacks jobs, the working people will start to commute. They make their purchases in or on the way to work and make use of services there. This in turn has an impact on local suppliers and companies in their hometown who then come under pressure and inevitably cease operations. As a result, a negative spiral may set in (Weber 2012) with further job losses and ever-falling purchasing power in the region. Younger and better educated people leave the place, the supply for the remaining ones continues to dwindle. To stop this trend, courageous initiatives with broad support are needed. Such developments can cause change in the other direction: workers find employment in the region and also make use of the services of local providers. The living conditions are attractive, so young families stay or move into the village. There is a positive climate in which people dare to try out new things: if it works, then it works!

The three-dimensional board of the game is designed as a spiral with different colours signalling the current development phases to the players. The players start together in the neutral area with dice indicating individual starting credit. The credit enables the players to purchase development cards as the game progresses. Players negotiate with each other over the development cards. Each development card offers different options for action, which the two negotiating players have to agree on without words.

The prototype of the game was presented to the steering group of the Carinthian Economic Association in December 2018. The members all found themselves in the role of the regional players from the board and were impressed by the simple set of rules, which reflects the dynamics of a region well. They particularly appreciated the fact that typical decision-making situations can be simulated and tested with the development cards. The game is designed in such a way that it can grow further and be adapted to the particular group of players. Each game set should contain blank cards for which the players can consider individually fitting dilemmas. In this way, the game also clearly promotes a discussion of the region and its development options. The Carinthia University of Applied Sciences is currently producing several models of the prototype. Following further revision and refinement of the rules, the Economic Association has also announced that the game will be officially published.

4. *Opportunities and challenges of applying game concepts*

Now that two exemplary implementation options have been described, some of the opportunities and challenges of gamification can be identified and discussed (Figure 9). First, it is clear that gamification can reach people on a non-scientific level who would not normally be attracted by technical content and facts. This opens up the outcomes of research to new target groups, increases the *outreach* and often allows the topic to be more clearly conveyed. This kind of knowledge transfer has proven to be very useful, especially for children and young people, as the players immediately have to take an active role and are no longer restricted to a passive listening role. The described games also show a possible handling of complex topics with different strategic variants. While it is difficult to explain that there is often no single "right" solution for a problem, the concept is much more understandable when participants are asked to try out different solutions and experience the conflict for themselves. In both games "Game of Clones" and "Regionale Spirale" the participants can *play with scenarios*, and thus play through the situations before they put them into practice. During the development and testing of the games, it was also noticeable that a strong part of the learning process takes place during the *participative development of the rules*. In this participative process all possible situations have to be explored and the learning contents and game mechanics have to be broken down into fine details. For this reason, game development can serve as a learning method itself.

Yet, it is precisely this development of the rules of the game that poses certain challenges, in particular the *balance between playability and realistic simulation* as well as between seriousness and fun within

the game. In order to handle this balancing act better, it can be quite important to provide different "hats" for the game developers. Some of them have to be responsible for ensuring that the game is fun and that the rules are clear, comprehensible and practicable, while others focus on ensuring that the facts and learning content are not neglected. Furthermore, the learning games that are developed during projects and workshops are often abandoned. Thus, as a further step, the *dissemination via market mechanisms* of such games must be considered, as they are often not the typical activity for a social gathering. Game publishers are often not equipped to disseminate these types of games, as they follow different functional logics. In the end, one has to be aware that these games will always be a niche product. In the context of participatory game development, the question of copyright and *intellectual property* also arises. The "game idea", i.e. the entire immaterial content of a game, can be protected by copyright. With many people working on a game, it must be assessed who has contributed to the set of rules and should become a co-author. For test games, one should collect the proposed rules and changes and independently decide which of them should be included in the game and which should not.

Digitising a game, as in our case with Game of Clones, opens many more possibilities, however, as the complexity of the system increases, players may find themselves unable to understand the underlying concepts so easily.

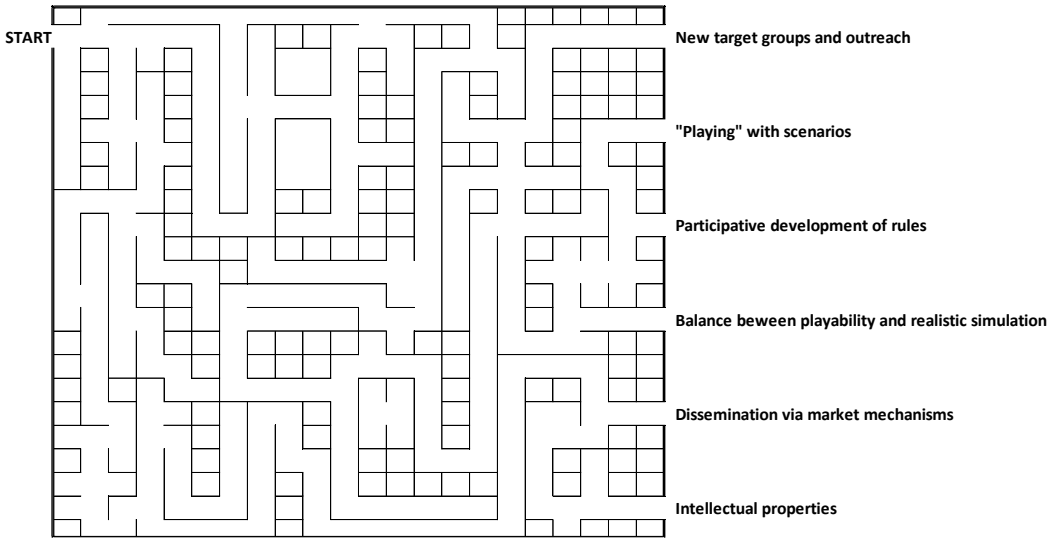

Figure 9: The maze of gamification: Find the way from the start to the chances and challenges of gamification

Gamification and games are a broad concept that offer many possibilities. If one knows their opportunities and limitations, then it is a powerful instrument for sustainability communication. In addition, they are also a convenient tool to communicate unpleasant messages in a playful way. Gamification reaches its limits when participants get the impression that the game is just a means to an end instead of making the learning process fun. While both approaches have to compete with other games and possible entertainment activities, the board game approach must also address the balance between the time a player invests into the game versus the amount of information and new concepts that are learned by playing the game. For example, a school schedule might not allow for playing a game for a longer duration than a school lesson. In the context of sustainability, we see a fair chance for the use of game concepts to convey issues that would be otherwise hard to explain. Whether a gamification idea has been successful is difficult to assess. Criteria for successful gamification would be helpful and target-oriented and would open new fields of research.

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