Educating Managers and Future Managers in Sustainability

Experiences from the Fishpond Experiment at the Berner Fachhochschule

https://doi.org/10.3991/ijac.v14i1.19457

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Abstract—The paper presents an implementation of the fishpond experiment as a means to help the development of a first-hand experience of the implications of individual and group behavior to the tragedy of commons. Apart from its value to teaching purposes, we see the value for exploring the potential of scaling up and transfer of its deployment to a broader audience not only in the educational curricula but also for professional development of future generations of environmentally conscious and responsible managers and corporate decision-makers.

Keywords—Sustainability, simulation, tragedy of the commons, fishpond experiment, executive learning, hands-on skills acquisition

1 Introduction

The active role of companies and the direct involvement of the corporate management - at all levels - as well as the employees is essential to address a number of challenges we are now since many years well aware of. Apart from climate change, there are a number of human-triggered actions that harm the environment and scarce resources, many times in an irreversible manner.

Changes in our behaviours also as citizens and consumers towards more sustainable patterns is something that can take place through education and raising awareness. We consider that what brings together to this challenge, both C-level managers and executives as well as young people like pupils and students, is not only the common risks we all face, but also a systemic lack of knowledge on what those risks are based on and how to cope with them. Most of us have been educated to understand mathematics later in our adult lives by having ourselves exposed early on in our first primary school years to the basic arithmetic operations of addition, subtraction, multiplication and division, while gradually we were taught about more advanced operations, such as manipulations of percentages, exponentiation and square roots, etc.

The acquisition of the necessary (and to a great extent digital) skills for coping with the challenges of sustainability are not any different: one has to start from basic notions and possibly develop a hands-on experiential understanding to this knowledge, in order to later make use of it in one's own decisions and personal or professional lives. Citizen science, observation and monitoring of the environmental impacts of human-made decisions or the lack thereof, as well as civic engagement and social innovations are a must - but there is a need for a framework where this extra knowledge will get accommodated; without a sound basis, sustainability becomes an empty phrase without any implications towards daily behavior patterns.

On the other hand, with the building of a firm and knowledge-based supporting background, the same people can be encouraged to change their personal and professional behaviours, their mindsets and their decisions, e.g. reducing their carbon and environmental footprints and taking other actions at the individual and collective levels that will eventually lead to a more sustainable lifestyle and relationship to the environment.

In the paper we present experiences from the implementation of the fishpond experiment as part of our combined and integrated teaching and research activities at the Institute of Sustainable Business and the Institute for Digital Enabling of the Berner Fachhochschule, and explore the potential of scaling up and transfer of its deployment to a broader audience both in the professional and educational curricula.

2 The Experiment

The so-called fishpond experiment is a popular exemplification of a deeply human problem that has been scientifically described already in the first half of the 19th century [1]. For over 130 years the problem has been described and discussed under different names, until Hardin [2] described it using the now well-known designation of "Tragedy of the Commons".

While the problem has initially mainly been recognized and addressed by economists, it is a classic social dilemma and as such applies to a countless number of topics and a wide range of scientific disciplines as demonstrated in the plethora of bibliography [3, 4, 5, 6, 7, 8, 9, 10, 11].

It is good to have a brief insight into the connection between the tragedy of the commons, on the one hand, and the fishpond experiment on the other: in a 1991 paper, Rose [19] states that Hardin [2] in their 1968 work may have picked the idea up from Gordon [18] and their work published in 1954, but there is a difficulty to solidly ground (or refute) this. Rose especially in [19] mentions in a quite foretelling if not even prophetic way that, 'Thus no one (except suckers, altruists, and fanatics) acts to conserve the fishing area, and depletion is its predictable ultimate fate' – a sad reality that the environment is globally facing and against which we need to act now to avoid the worst impacts of our efforts to control the multi-faceted aspects of the climate change.

However, the reference to Hardin [2] may be problematic as it 'requires a fundamental extension in morality', to use the author's own words. What modern managers may now acutely need to be trained for is the shift from (moral) values to preferences, both for individuals and communities, with the aim to facilitate behavioural change and long-term commitment, trust, social acceptance and buy-in of the notion of sustainability and its implications to all aspects of corporate activities, through effective strategies that shall go beyond nudging. This is stated in [20] where it is confirmed the non-lasting nature of nudging which we aim to overcome by means of educating the managers in a hands-on way.

Due to the broad selection of fields of application to choose from, the possibilities of how to visualize the basic problem of the Tragedy of the Commons are virtually endless. Nevertheless, the decision to visualize it using the intuitive example of a fishpond or its dry land variant of the cow pasture has been made and remade by different institutions and entities. Searching for the term 'tragedy of the commons' on video platforms like YouTube or Vimeo illustrates that impressively.

The goal at the core of the project was the idea to allow our students to experiment with such a system of commons in real-time and make them experience the consequences of their own actions in flexible scenarios. These scenarios would need to start off by giving the group of students a common goal and then increasingly pit group interest and individual interest against each other. The main idea was to make the students experience the mechanics and consequences of the tragedy of commons before discussing it with them in theory to demonstrate that while solving the problem in theory is seemingly easy, human nature can turn it into an almost impossible problem.

For this, a very simple Excel-based system was created with the goal to test students' reactions and then decide how to proceed further. In this system, players could not be individually tracked but only counted, as a free, web-based survey tool was used to gather the players' decision how many fish to catch in each round of the game.

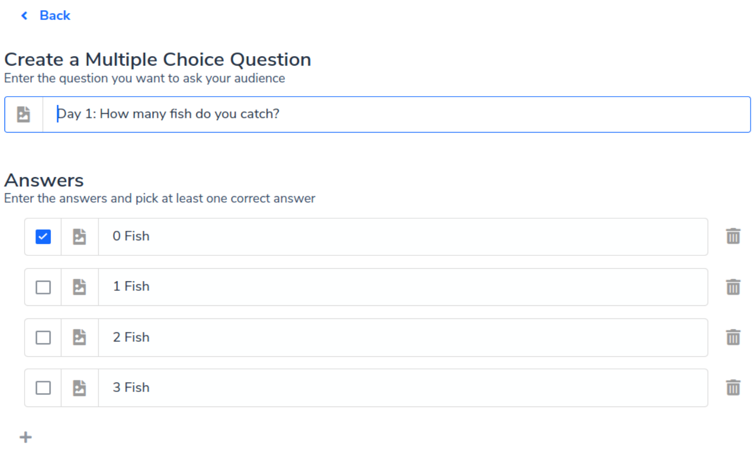

Fig. 1. An online survey tool was used to gather the information of how many students decide to fish how many fish on a particular day.

The data was then manually entered into an Excel sheet in order to get the resource levels for the next round. Besides the initial resource levels, all parameters were fixed and could not be changed in order to create different scenarios or offer different behavioral patterns to the students. Deciding to fish between zero and three fish was all they could decide to do.

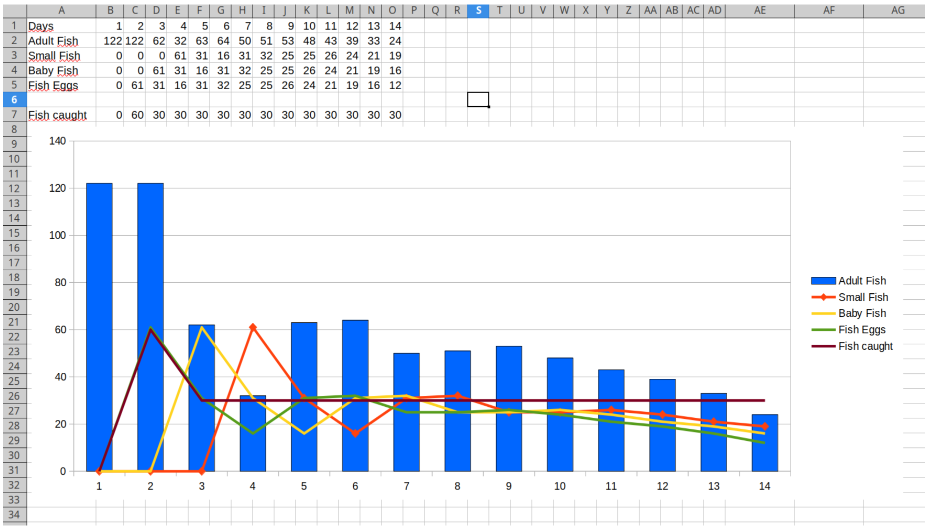

Fig. 2. Sheet-based version used to test concept with students: This is where the students would see the consequences of their actions.

After the very positive feedback by the students, the decision was made to create an improved, web-based version.

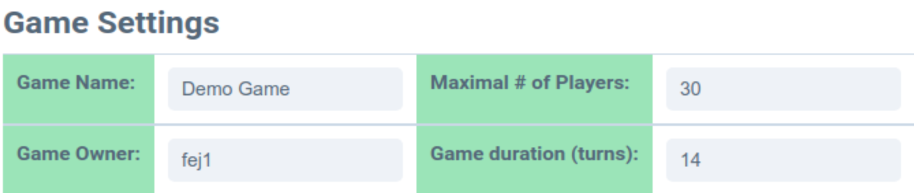

Fig. 3. More options to shape a game, e.g. vary the game duration.

This not only offered a more intuitive visualization of the resource situation but also allowed for more configurable game settings and more options for player actions.

Fish(-ing) Settings

Fish needed per day:	1	Minimal # of mating fish:	2	Reproduction Variation (%):	0
Maximal daily attempts:	3	Fish Visibility (batch size, 1 = exact number):	1	Players starve after x days without their fish ration:	1
Initial fish storage:	1	Fish spoiled after x days (0 = does not spoil):	1	Player chance to catch fish (%):	100
Offspring per mating fish:	0.5	Fish Market:	◉ Market Closed	○ Fixed Fish Price	○ Variable Fish Price

Fig. 4. With a web-based version, initial conditions, player options for action, fish behavior, environmental factors, or simply the factor of luck could be added to the game.

Fish Population & Phases (0 = youngest)

Phase	Phase Name	Phase Start Level	Phase	Phase Name	Phase Start Level
#0	Fish Eggs	0	#5		0
#1	Baby Fish	0	#6		0
#2	Small Fish	0	#7		0
#3	Adult Fish	100	#8		0
#4		0	#9		0

Fig. 5. To simulate that there can be delays between an action and its consequence, the web tool offered the option to vary the number of growth phases and their initial levels.

Random Events

Event Name	Event Description	Event Probability	Event Impact
Delayed Development	A certain percentage of fish remains on their maturing level in this turn	0	1
Bad Catch	The chance to catch a fish is x percentage points lower this turn	0	1
Disease Outbreak	A percentage of the fish population dies this turn	0	1
Murky Waters	Fish visibility changes to this batch size this turn	0	1
Reduced Fertility	A certain percentage of mature fish cannot successfully mate this turn	0	1

Fig. 6. To add the factor of uncertainty, the web-based game offered the choice of adding events to the game that might or might not take place during the game, heavily influencing its course.

In order to give the group and its individuals within the group different motivations, the game could only be won, if the entire group survived. At the same time, the player with the highest amount of gold (from selling surplus fish) wins the game. The students' motivation could be obviously increased if winning the game led to a reward, e.g. price money. The fact that the entire game was anonymous made sure that no peer pressure would be applied, and every individual acted freely and according to its own goals and values.

While the Excel sheet-based variant of the game already allowed the students to realize that they would have to coordinate their actions in order to have a decent chance to win the game and that even very few deviators could ruin the game strategy for everybody, the web-based game offered even more insights to discover and experience.

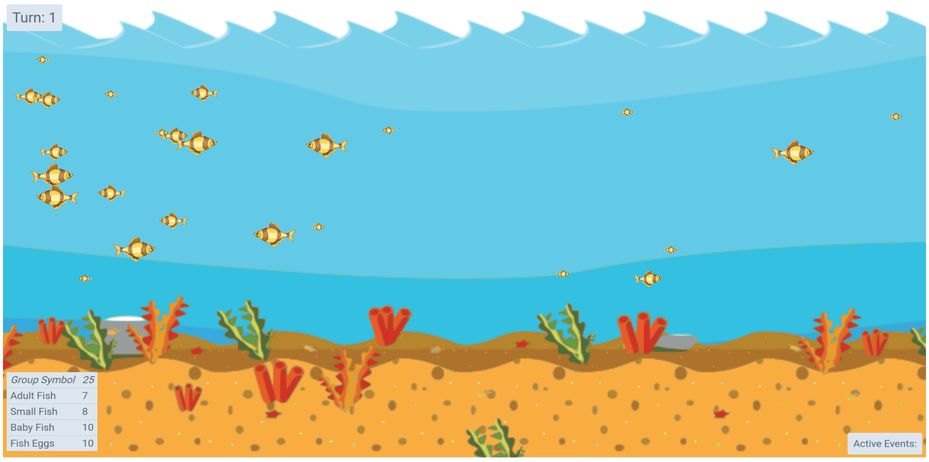

Fig. 7. Visualization of the current resource situation in the fishpond and the active events.

With the new, more flexible setup, different scenarios could be played with a class of students, e.g. depending on how successfully they have mastered the previous one. Going through several scenarios, the students could experience first-hand how factors like the uncertainty regarding resource yield, unreliable information regarding resource availability, the pressure of having to make use of a resource before it spoils or the temptation to get an unusually high price for selling the resource influences individual decisions and consequently the result for the entire group.

3 Experiences and Feedback

Looking back at the experiences made with several classes since the first iteration of the Excel sheet-based game about a year ago, the following experiences and student feedback came up repeatedly:

Students in the beginning underestimated what it takes to win the game. Every class was rather surprised when they ran out of fish for the first time, apparently not having expected this outcome and not yet understanding what exactly brought them into this situation.

- Regardless of whether the students were told in advance that coordination is the key to win this game or not, they did not try to communicate or coordinate for the first few rounds. Only when it was painfully clear that individualistic approaches constantly lead to failure, they began to self-organize.

- While a few groups mastered the scenario where fishing just a bit more than actually needed for survival is enough to win the game, no group mastered the scenario where no member of the group can go beyond their bare necessities in order to win the game. The scenario, where the entire group had to put off fishing as long as possible in order to give the fish time to reproduce undisturbed, resulted, consequently, in even worse results.
- In every group so far, at least one individual did not back the strategy previously defined and agreed on by the group. Due to the fact that players remain anonymous, no further information about these persons and their motivation could be acquired.
- Best and fastest results were achieved when one student took the initiative and structured the coordination process of the group as a moderator. Classes without a moderator, self-organizing in several, smaller groups also eventually achieved victory but it took them more attempts to do so.

Finally, it should be noted that games played with university staff members instead of students did not result in faster coordination or better results. However, since these test rounds have only been very few, this phenomenon might be anecdotal.

As a result of the experimental sessions we had in playing the game with our students at the Berner Fachhochschule, we have come up to the following findings:

1. If one ignores the test games used to explain the handling of the game, student classes tend to improve from attempt to attempt. But it is hard to tell what causes this improvement. Some of the possible interpretations may be that this is due to (a) a better understanding of the Tragedy of the Commons, (b) acquisition of the capacity at a collective level for better coordination, or (c) self-corrections of individual behaviours to allow for a better adaptation of individual strategies at a collective level, etc.
2. The correlation matrix (Figure 8) does not show anything unexpected as it rather signifies the correlation of the variation of fish sold per player and a few other interesting variables, namely:

- The longer fish takes to spoil, the larger the variation in individual player's selling behaviour
- The longer players can go without food, the larger the variation in player selling behaviour
- The smaller the chances to catch fish, the larger the variation in player selling behaviour
- The higher the limit for fish caught per day, the larger the variation in player selling behaviour.

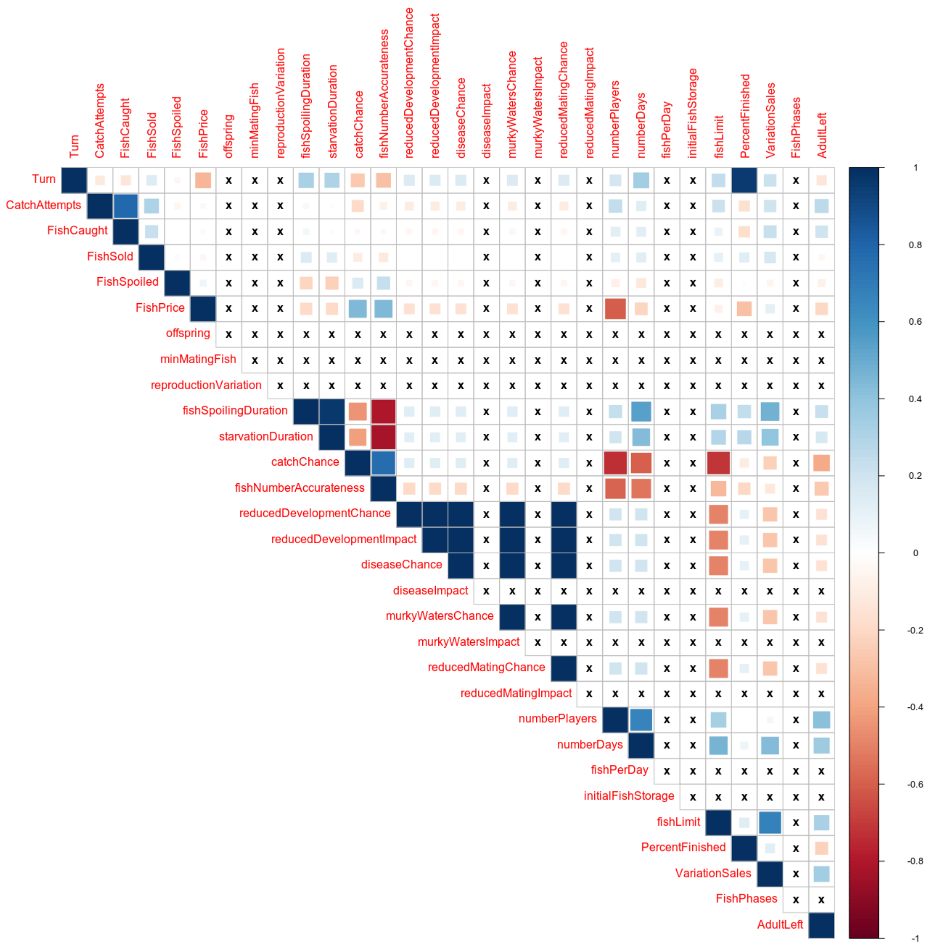

Fig. 8. Correlation matrix showing the relative percentage of completed rounds of the game for each of the players.

So, we realized that the students get better at playing the game and we were also able to recognize that in general the more leeway the players get, the less uniformly they behave. To us this degree of uniformity seems to be a good indicator of coordinated behaviour or lack thereof.

What we also see as confirmed is the need to change thinking and acting patterns for achieving sustainable development goals in managerial scenarios starts from educating our students in this way; people who never learned to learn what it takes to cooperate instead of competing may not learn this later in their professional careers when out in the market. Based on oral feedback from the students after playing the game, forming a collectively advantageous strategy has been an entirely new challenge for some of them.

Four corollaries that we think will be worth considering and explorng in the necessary depth are:

1. Participants tend to develop cooperative behavioural patterns and this has improved during the next rounds of the game. Consequently, cooperative behavioural patterns need to be practised and taught.
2. There was always the possibility of an outlier, i.e. a person that followed their own individualistic optimisation approach. In those cases, the majority of the participants continued to stick to the cooperative behaviour, ignoring or separating the outlier from them.
3. There were incidents where individual players changed their strategy mid-game and aimed to increase their winnings in certain rounds – soon afterwards returning to their normal (cooperative) behaviour.
4. Analysing the game progress and results is not enough to understand what is going on. Surveying the players before and after the game would result in a better understanding of where the players were before the game and where they found themselves after the game with regard to their knowledge and perception of sustainability strategies. This could help a better understanding of motivations behind different action patterns.

This is not a new finding at all and confirms findings we were taught in textbooks on game theory [16] or more findings confirmed from the area of behavioural game theory [17].

4 Discussion and Future Research

Both from a societal and an economic point of view, we need to increase and intensify our efforts for strengthening environmental awareness of the young generation through education and other forms of engagement. Parallel to this, we have to also educate all levels and generations of citizens and professionals that are part of what we usually call ‘the economically active population’ to acquire some basic skills that will help them understand the problem and then lead them to all the necessary steps that will effectuate changes in their ways of thinking and acting.

As recognised in the European Green Deal Communication [12, 13], schools, training institutions and universities are well positioned to engage with pupils, parents and the wider community on the changes needed for a successful transition to a green economy. To this, it is essential that a context needs to be developed that will help the stepwise development of knowledge, skills and attitudes. What brings together the owner of a small- or medium-sized enterprise who thinks they can afford to waste scarce water resources or use environmentally unfriendly or even harmful processes for their production or service delivery processes, and a young primary school pupil is the lack of knowledge. And while for the latter, they may have the opportunities to learn in the next years, the former as part of the active economy needs to be re-trained to respond to the existing challenges.

Some future directions for the fishpond experiment we aim to undergo:

Specialisation for specific domains and areas: While the fishpond offers a sound basis for sustainability teaching, it is to a great extent a metaphor or an analogy for the lack of a sustainable ways of acting and doing. This leaves a wide empty space in the minds of people that is difficult to fill out with data or information that are relevant to their own areas of professional engagement. The conclusions to draw from the fishpond experiment are different to the owner of a fast-fashion manufacturer from the conclusions to a restaurateur who opens and operates regional or nation-wide restaurants. While the fast-fashion manufacturer may need to operate an international supply-chain with suppliers he may never have the opportunity to physically meet and have a first-hand experience about their methods or inspect on their own their facilities, and customers who may again be all over the world, the regional-scale restaurateur may face totally different challenges and may have a totally different "space for manoeuvering".

Increase of the gamification aspect: The application of gaming technology for real world simulation, scenario development and training comes under the heading of Serious Games in the games industry. Serious Games represent a convergence of electronic gaming technologies with instructional design principles and pedagogies. Selection criteria for game engines and the choice of platform for Serious Games are substantially different from entertainment games, as Serious Games have very different objectives, emphases and technical requirements.

The possibilities for small, modestly-funded teams of software developers to produce good quality games have improved rapidly in the last years and since the first genuinely powerful general purpose "game engines" became available. The first game engines, such as Torque by Garage Games, were in essence the lower-level code taken directly from commercial games. These early game engines represented a huge democratization of the industry. More recently, and especially with the rise of the smartphone App Stores and other reduction in barriers to entry, we have seen the development of game engines which were written from the ground up with the explicit intention of being general purpose engines rather than being adapted from commercial games. Engines such as Unity 3D, Shiva, and Unreal have paved the way for "write once, deploy anywhere" development, allowing game developers to focus on their core game experience without having to worry about cross-platform deployment or the lower-level coding of the generic software features which underpin all games.

Core developments we regard for the future are, amongst others, the following developments:

- 3D/virtual reality multi-user sustainability training environment, incorporating high-performance networked gameplay with features such as voice-over-IP, virtual reality headsets, etc.
- Sets of pre-packaged template scenarios, developed in collaboration with stakeholders like international organisations, e.g. UNESCO [14], the European Commission, national governments, economic area stakeholders (agrifood, fashion, automotive, transport, pharmaceuticals and chemicals industry, etc.), and including narrative gameplay scenarios which will be replayable due to accurate underlying simulation and modelling of key parameters

- Customisation modules, allowing new localised 3D content (buildings, public spaces, etc.) and simulation parameters such as local laws, cultures and languages, to easily be added, thus producing localised training scenarios. Sustainability may be the common theme but the way to implement it may be different for an Italian winemaker than for a French one; or even to a scale of higher 'granularity': sustainability for a French winemaker in Alsace may need a different path to take than a winemaker in Bordeaux, same as for an Italian winemaker in Tuscany than one in Puglia or in Basilicata.
- A set of generic 3D content for use in subsequent localised scenarios, accompanied by the necessary systems and modules for automatic or semi-automatic creation of localised physical spaces based on available data regarding roads, traffic, building footprints and so on.
- Diagnostics modules allowing real-time summative overview and statistical analysis, as well as the automatic recording and multiplayer playback of all deployed 'game' events, allowing the extraction of learning analytics that will help us see exactly what users learn and how their behaviours change over the time. This would also allow geographically dispersed teams of analysts to review and discuss and when necessary even doubt the concepts of the sustainability training.

We are very well aware that the way towards sustainability is not as easy as it seems: apart and beyond the generic level that relates to high level concepts and abstract notions, one needs to come several layers down to practical questions and aspects that are the ones that people usually confront themselves with on a daily basis and which are the ones that affect our daily routine decisions.

For example, the idea of profit is a generic "abstract" notion that for some bigger, public companies relates to their quarterly earnings reports, while for smaller companies may become a 'killing factor' (or at least this may be what the owners may perceive or be afraid of).

The toxic effects of hundreds of years of unsustainable, unreasonable development and growth policies are not easy to overcome only with good intentions and a simple (though well-received) fishpond simulator. Many efforts are needed to take place in a concerted fashion and at all levels. The important thing is to change our perspective, from having us the humans regarding ourselves as the big fish in a small pond, to seeing ourselves as one of the many small fish in a big(ger) pond. Our planning and ways of thinking will then start to change. An important game-changer to this is the role that citizen science can play as a powerful tool to increase civic engagement.

In this respect we see the need for a follow-up research that will allow us to include a pragmatic non-randomized controlled study and on a total of a larger sample than the one used for our small-scale experimentation. Such a larger sample size will enable significant statistical inferences to be made and together with qualitative interview data will have the potential to robustly demonstrate the impact of the use of the fishpond experiment to educate future generations of managers and/or students. Pragmatic studies offer the opportunity to obtain real-life data on the relative effectiveness of interventions and they have been widely used in the area of health interventions compared to a control group without an intervention [15] though there is little experience in the area of management, as is our aim for future research in this area.

5 Conclusion

A key factor in achieving sustainable development goals is for individuals to change their thinking and acting patterns. In the paper we present our experiences from the implementation of the fishpond experiment with the goal to allow our students to experiment with such a system of commons in real-time and make them experience the consequences of their own actions in flexible scenarios. These scenarios would need to start off by giving the group of students a common goal and then increasingly pit group interest and individual interest against each other.

The main idea was to make the students experience the mechanics and consequences of the tragedy of commons before discussing it with them in theory to demonstrate that while solving the problem in theory is seemingly easy, human nature can turn it into an almost impossible problem. Changes in individual citizens' and professional policy and decision makers' behaviours towards more sustainable patterns can happen only through education – in this context, the collective exposure of the users to the fishpond experiment may provide them with a hands-on experience of the 'tragedy of commons' not as an abstract or vague potentiality but as an inevitable result of human behaviour.

Many of the core ideas and the approach we promote in the teaching sessions has been influenced by the reading of 'Factfulness: Ten Reasons We're Wrong About the World – and Why Things Are Better Than You Think' [21]. The book suggests that the vast majority of people are wrong about the state of the world, showing that we tend to believe the world is 'poorer, less healthy, and more dangerous' than it actually is, attributing this not to random chance but to misinformation. Same as Rosling suggested ten rules of thumb to help avoid 'over dramatic interpretations' and instincts that prevent us from seeing real progress in the world, it was our ambition with the fishpond experiment to help students come up with actionable behavioural change suggestions, namely change in the way they individually play the game to win, but with a longer term perspective. This will help sustainability acquire a business sense rather than an ethics-related identity, as it is currently mainly the case.

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Article submitted 2020-10-26. Resubmitted 2020-12-16. Final acceptance 2021-03-19. Final version published as submitted by the authors.