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► **To cite this version:**

David Luidold, Meike Belter, Éléonore Sas, Weronika Szatkowska. Evaluating a Game on Sustainability and Collaboration with German Logistic Students. 54th Conference of the International Simulation and Gaming Association, Nicolas Becu, Jul 2023, La Rochelle, France. pp.halshs-04209935. hal-04273324

HAL Id: hal-04273324

<https://hal.science/hal-04273324v1>

Submitted on 8 Nov 2023

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Evaluating a Game on Sustainability and Collaboration with German Logistic Students

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Abstract. This paper summarizes research conducted by the authors during the ISAGA Summer School 2022 in Stuttgart, Germany. A research design for the exploration of collaborative and competitive game behavior as well as for the thinking patterns of the players was developed and finally conducted. As a simulation game to promote sustainability, the Fishing Game was chosen, played and evaluated with German students during the Summer School. In the results there were novel and unexpected findings, which provided insights into learning and game processes and can be helpful in game development as well as moderation of simulation games. The players showed no signs of collaboration within the game. Even after the game, the majority of the players stated that they would not show any intentions to change their behavior in the future. The reasons for this can be summarized as: 1) economics (sustainability is not compatible with economy), 2) prior knowledge (the problem was already known to the players before the game), 3) sustainability (there should be a greater focus on sustainability), 4) not implementable (a collaborative and sustainable behavior is not realistic). Those individuals with an intended behavior change indicated that a decreased competitive mindset leads to greater sustainability. In this study, the importance of debriefing can also be confirmed for failed game sessions. The implementation of the debriefing led to the fact that considerably more players created a connection to reality and were more likely to achieve the pedagogical goal of the game.

Keywords: Simulation games, game evaluation, debriefing

1 Introduction

Collaboration stands for one of the core competences of societies on the pathway to sustainable development (Lozano, 2007). Although we could expect sustainability games to encourage collaborative attitudes, there was little written on the promotion of cooperative behaviours by simulation games on sustainable development. As a group of students, we decided to conduct a quasi-experiment and investigate the encouraged behaviours among players of a popular sustainability game.

The research presented in this article was conducted under the umbrella of the ISAGA-Summer School and with the aim of exploring game evaluation methods by the participants of the summer school (authoring the article). The ISAGA 2022 International Summer School was held from September 26th to 30th in Stuttgart (Germany) on the theme of “Evaluation and Research in Simulation and Gaming”¹.

As a case study of a simulation game on sustainable development we have chosen *Fishing Game*, a game about common resources management. Preceding the creation of the game evaluation, the game and its mechanics were closely examined and experienced by the research team. Concluding this, we focused on exploring collaborative and competitive behaviour during game play, as well as the extent the *Fishing Game* evokes collaborative or competitive thinking patterns in participants.

¹ The report on the summer school can be found here: <https://zms.dhbw-stuttgart.de/artikel/isaga-summer-school-2022-at-the-centre-for-management-simulation/>

In the course of the study, we formulated the overall research question: To what extent does playing the *Fishing Game* foster more collaborative – rather than competitive – behaviours among German students in logistics. As the participants sample was very specific, this research also focused on the impact of individual character traits on a shift from a game level to a meta level, following the concept of Koodamara et al. (2021). To explore this, the game was played with a group of 19 German students in logistics with an average age of 20.84 within a university classroom. The game evaluation method consisted of survey observations and was constructed based on various methodological concepts and literature.

2 Related work

2.1 Literature

There are common findings, indicating that simulation games have the potential to raise awareness about sustainable actions and to let participants experience the dilemmas related to sustainability transitions (Douglas & Brauer, 2021; Kriz et al., 2001). Simulation games are already widely applied to raise awareness of diverse aspects of sustainability, promote reasoning abilities, as well as to rationalize and synthesize information (Torres & Macedo, 2000). Among meaningful examples, there is KEEP COOL, a board game about climate change designed to provide a discussion platform for people of multiple disciplines (Eisenack, 2013). In general, simulation games for sustainability are important tools for education and teaching (e.g., McGrath et al. 2020). However, different meta-analyses show the context dependency in efficiency and the importance of planned game designs to provide a good learning opportunity for the game players (Platz 2020; Erhel & Jamet, 2013).

To enhance the contextualization process, insights into the play and context-specific learning affordances are helpful. Based on these results, adaptations and adjustments can be made. Here, the simulation game KEEP COOL could be used as an example: the efficiency of the learning opportunities was analyzed and insights into the black box of the learning processes were provided. This revealed that behavior during the game - whether cooperative or competitive - has no impact on potential behavior change. Hence, in the designing and moderating of simulation games there is no need for consideration of desired relations between players, at least in the context of sustainability (Meyer & Eisenack 2018).

Additionally, competitive games can simulate real-world economic and social systems, allowing players to experience the trade-offs and complexities inherent in sustainability decision-making (Farmer 2015). In designing games for sustainability, it is important to strike a balance between collaboration and competition, as both can contribute to players' understanding of sustainability issues and their ability to make informed decisions. Importantly, in some strategic games, which is the case of *The Fishing Game*, there is no imposed game mode and players decide themselves what attitude they would adapt. While this allows participants to examine their competencies, it also poses a threat to the learning process and limits the control of the facilitator over the expected outcomes.

The study by Kolarowa and Ziaran (2016) was an entry point to analyze cooperative and competitive tendencies in the research. The authors elucidated the relation between personality traits and cooperative and competitive attitudes. In the study, they included 11 core competencies and associated them with cooperative/competitive tendencies. The full list of competences is included in the appendix.

Based on the example of KEEP COOL, we decided to investigate cooperative and competitive behaviors of the participants. However, in contrary to the example of KEEP COOL evaluation, we decided to include the post-game survey after the debriefing, not exclusively before. The literature identifies debriefing as one of the most essential phases of a simulation game (McBurnett et al., 2018; Kriz & Nöbauer, 2012; Crookall, 1992). A simulation game without debriefing is described as a missed opportunity (Tafner & Dreisiebner, 2019, p. 134). This

statement can be justified by the fact that also in the framework of the experiential learning cycle according to Kolb (2015), a feedback loop is mandatory, thus, we find debriefing to be an immanent part of simulation games. In this vein, the present study proposes a pre-game survey and two post-game surveys (one immediately after the play session and one after the debriefing).

2.2 The Fishing Game

The Fishing Game is a pool resource dilemma game. It was designed for the Allied Media Conference of 2013, and it was inspired by – and then simplified from – the Fishbanks Game of Dennis L. Meadows (Crookall et al., 2019). The two games address the growth's limits and the “tragedy of commons” phenomenon, also known as “unregulated commons” (Hardin, 1968).

In more concrete terms, the *Fishing Game* players are divided into four teams. Each one of them manages a fishery. All the team-fisheries operate in the same region, selling and feeding the fish to the same population. The goal of the game is to have the most fish by the end of the tenth year (one game round represents one year). This game objective is transmitted to the players deliberately in exactly this formulation. The players are free to decide whether they think of a competitive situation (as most players do) or whether they recognize a dilemma on a cooperative level. A round proceeds as described in the insert card below (Figure 1).

1. SHIPPING: the teams play one of their technology cards simultaneously.
2. COLLECT: in a determined order, each team collects the number of fish corresponding to the technology card they have played - if there are any fish left. Some technology cards can only be activated if there are "more than 15 fish left in the lake" at the time of fishing.
3. MARKET PRICE: depending on the total number of fish caught in this round, the unit price of the fish changes. In a logic of market competition, the more fish the teams have collectively caught, the lower the fish unit price becomes.
4. INCOME: each team receives the amount of money equal to the market price multiplied by the number of fishes they have caught this year.
5. INVESTMENT: teams can choose whether or not to buy a new technology card. (This type of game tends to produce a certain amount of technical inertia as it pushes players to invest in technologies and to make sure they get value for their investment over the course of the game.)
6. REGENERATION: at the end of each round, the fish population is regenerated. For every three fish remaining, one fish is added to the lake. At the beginning of the game, there are 24 fish in the centre of the lake.
7. END OF YEAR: The round number marker moves up one step forward (there are 10 rounds in total). If the total number of fish caught during the round was more than 7, the population is happy; otherwise, they are starving. After three consecutive turns with less than 7 fish caught, the population starves. In that case, the game ends automatically and everyone loses.

Fig. 1. Card 1 - Description of the phases of the Fishing Game gameplay.

The “Market Price” phase proposes a "balancing loop": the greater the supply, the lower the selling price. This feedback loop should normally prevent overfishing. However, if the number of fish available in the lake drops drastically (due to the fish regeneration rule for example), the market can no longer be flooded: in order to win, each team is then tempted to extract the remaining resources to sell them even more expensively. This reinforcing feedback loop is a trap in the system, known as the "tragedy of commons".

The tragedy of commons refers to the draining of a shared resource by individuals who operate independently and rationally based on their own personal interests, even if they understand that this kind of behaviour is contrary to the best long-term interests of the group. When this happens in the *Fishing Game* – when it becomes clear that the pool is not sufficiently regenerated while the population begins to starve – the teams often start to trade, to negotiate (sometimes opening to betrayal) or to blame each other.

2.3 Debriefing

After playing the *Fishing Game* there is a facilitated debriefing. It is designed as a group discussion and led by the same person responsible for gameplay facilitation. Concerning the game session discussed here, the debriefing itself was structured in four *E* questions (adapted from Bartschat & Zürn 2018; Petranek, Corey & Black, 1992): emotions (“How did you feel?”), events (“What happened?”), experiences (“What did you learn?”) and every-day life (“How could you use your learning?”).

The questions were supplemented with additional reflective insights provided by the facilitator, i.e. what an ideal strategy would look like (cooperation, low investment, less fishing with a high price), what is winning – does it mean to possess more than others or could it mean equal benefits for all the participants. Finally, the facilitator explained one sustainable solution of the game and discussed success and failure strategies.

3 Research Design

This experimental session took place on the 28th of September 2022 at the Center for Management Simulation of the DHBW in Stuttgart, Germany. There was one facilitator dealing with the four teams, each composed of four or five students. The teams were assigned randomly and distributed over four tables arranged in an arc in front of the facilitator and a central table (on which the fishing pool was placed). The global game information (such as the year tracker or the fish market prices) were also posted in front of all teams, in this central place.

3.1 Preconditions and Participants

A survey before the actual game starts allowed a better estimation about the players. This questionnaire was used to know about demographic data (age, gender), previous game experience, motivation to participate, and anticipation of the simulation game. In addition, questions were asked about cooperative or competitive behavior based on Kolarowa and Ziaran (2016).

The sample consisted of 19 participants aged 19-26; seven women and 12 men. All participants were students of a Bachelor of Logistics at a German university. The study was conducted as part of compulsory classes. The group had limited knowledge of simulation games. 74% of the players declared little experience in simulation games (1-3 games played before), the rest experienced 4-10 gameplays and only one person experienced over 10 simulation games. The group was diverse in terms of the frequency of playing games. Mostly, however, the participants did not play too often: 53% of the students play less frequently than once a week. Nine participants declared that on average they play games once a month, while one person plays a few times a month, six people play once a week, one person never plays games, and one person uses to play every day.

In terms of the preferred game genres, participants indicated rivalry-oriented games focused on individual results: competitive, strategic, and sport games (59%). None of the players indicated cooperative games as the only choice – even players who play Massively Multiplayer Online Role-Playing Game (MMORPG), sandboxes, or other cooperative games indicated also competitive games (participants had multiple choices in this question).

3.2 Debriefing structure and instruments

To evaluate to what extent playing the Fishing Game fosters more collaborative - rather than competitive - behaviors among German students in logistics, the authors created the following debriefing protocol. After introducing the research context and before starting to play, the participants filled an individual questionnaire to assess their attitudes towards competition and cooperation. Then, during the gameplay, observations of collaborative and competitive behaviors were conducted. It was based on an observation matrix completed by two independent observers associated with each team and with an action-tracking grid completed by the players themselves. Finally, the participants completed another individual questionnaire before and after the debriefing to evaluate the impact of the game on their thoughts about cooperation (with and without the hindsight on the briefing).

The debriefing consisted of two tests: first questionnaire (T1) immediately after the playing part and, therefore, before the debriefing. Then, second questionnaire (T2) after the debriefing. The role of pre- (T1) and post-debriefing-survey (T2) was to determine the influence of debriefing and its effectiveness. To avoid declarative statements regarding the knowledge gained, participants were requested to answer an open question with minimum 3 statements. Similar question was asked after the debriefing. Eventually, the outcomes of the comparison of the two questions were analyzed.



Fig. 2. Research design with the assignment designations

The pre-debriefing questionnaire (T1) included the question “What would you change if you played again?”. The structure of this question was an attempt to gather reflections from the game before the debriefing. It was expected to trigger the core learning points acquired by the participants.

The post-debriefing questionnaire (T2) was conducted immediately after the debriefing. It consisted of a similar question to the initial one: “What advice would you give future players?”. This way, it verified whether participants reached or not the meta-level in post-game reflections. The question was formulated in a different way to avoid repetitive answers; however, the sense remained the same. In addition, participants were asked three direct questions about the impact of the game. The first one was a close-ended question: “Do you think that the game will influence your future behavior?”. Participants were asked to explain their answer. Then, two Likert scale question/sentences were proposed: “How likely is it that you would recommend the game to your friends?” and “I enjoyed the game” (Strongly disagree - Disagree - Neither agree nor disagree - Agree - Strongly agree).

3.3 Observation

To gain insight into decisions and considerations during the game process, the teams’ behaviors were observed. Two observers were assigned to each team – one observer representing the students (who then did not participate in the game) and one external observer (a participant of the Summer School). Data points were collected through an observation sheet followed by the questions to be found on figure 3.

GRUPPE Nr: The letzten drei Stellen deiner Handynummer:

Answer the following questions about every round:	Scale	ROUNDS									
		1	2	3	4	5	6	7	8	9	10
Did your team talk to any other team?	YES or NO (Y/N)										
Did your team suggest any collaborative activity with other teams?	YES or NO (Y/N)										
Did your team agree to any form of collaboration with other team/teams?	YES or NO (Y/N)										
- If so, did your team decide to cheat the agreement?	YES or NO (Y/N)										
Was the most important team's goal to maximize its own result?	YES or NO (Y/N)										
Was the most important team's goal to achieve "the greater good" ? (feeding the population, regenerating the lake etc.)	YES or NO (Y/N)										
Did your team intentionally catch fewer fish that they could have? (e.g. you could catch 3 but decided to catch only 1)	YES or NO (Y/N)										
What was the overall level of positive emotions in your team? (happiness, satisfaction, pride, enjoyment, etc.)	5 – very strong										
	4 – strong										
	3 – medium										
	2 – weak										
	1 – very weak										
What was the overall level of negative emotions in your team? (anger, fear, powerlessness, shame etc.)	5 – very strong										
	4 – strong										
	3 – medium										
	2 – weak										
	1 – very weak										

Fig. 3. Observation sheet.

4 Results

This chapter outlines the results of the study. First, the preconditions of the players from the T0 surveys are explained in order to get a better understanding of the group – the focus is on the dispositions between cooperative or competitive. This is followed by an analysis of the results from the post-test questionnaires, considering both quantitative and qualitative aspects. Finally, qualitative data obtained from the questionnaires is compared and evaluated. Due to an unexpected and special game dynamics (the players had hardly sought cooperation throughout the game), no more significant results emerged in the observations: therefore, they have been omitted in this chapter. However, if this project is pursued further and cross-national games are played, a renewed observation should nevertheless not be dispensed with.

4.1 Personal Characteristics of Test Group (T0)

Eight questions under the umbrella of the administered pre-game questionnaire provide insight into characteristics of the participants commonly associated with either collaborative or cooperative thinking patterns (Kolařová & Pavel, 2016). For each question (Q1-Q8), a 5-point-likert scale was used ranging from "Very unlikely" (1) to "Very likely" (5). All participants (n=19) answered all questions. The results can be seen in Figure 4, which shows the relative distribution of responses per category. Particularly noteworthy are the high values of social capacity (Q1) - 52.6% indicated "very likely" and 21.1% "Likely". Likewise, the group shows high ambition (Q7) with 68.4% indicating a score of 5 and 31.6% indicating a score of 4. Finally, the question on "Capacity to influence people" shows a distribution from "Not sure" (3) to "Very likely" (5), with 4 being the most frequently indicated with 42.1%. Figure 5 shows the average scores per indicator question on a scale of 1-5.

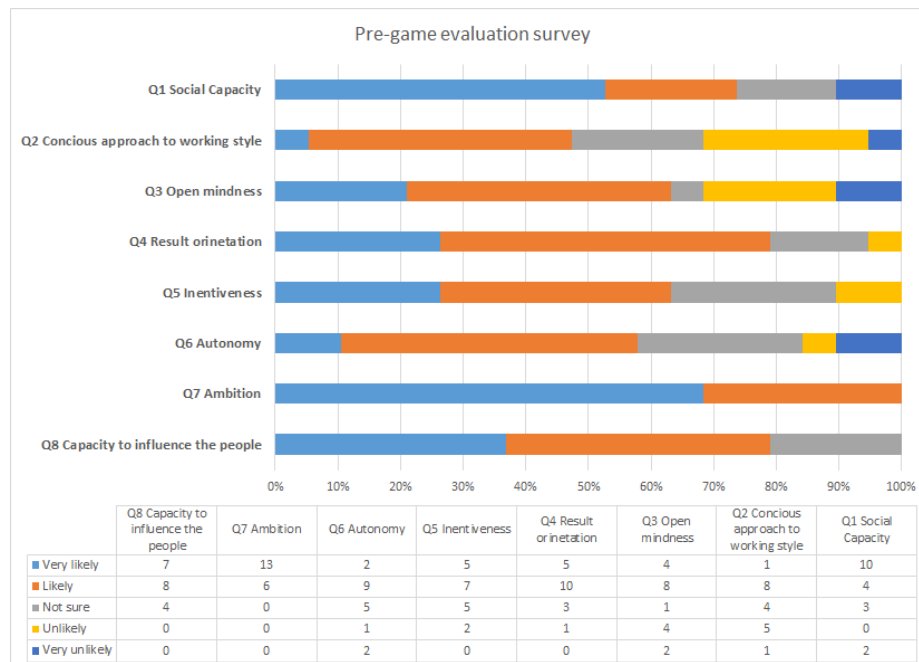


Fig. 4. Pre-game questionnaire results.

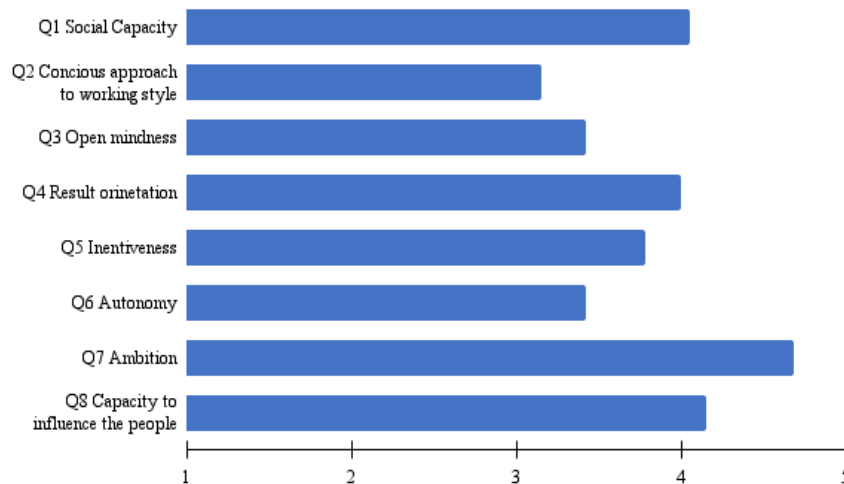


Fig. 5. Average values per indicator question on a 5 points Likert-Scale.

To investigate the relationship between our variables (items) further, a Principal Component Analysis (PCA) was performed in SPSS. The KMO value can be reported as insufficiently strong ($KMO = .314$), however communalities for all items showed a sufficient explanation of total variance ($>.7$) by components in the model of analysis (4). While the amount of variance explained by each component is limited due to a low data count, the variance for the first components may well be indicative of the underlying structure of the data. This analysis resulted in 4 components explaining the total variance of the 8 items. Here, it was apparent that (Q4) “Result orientation” - (Q8) “Capacity to influence the people” loads strongly into component 1, whereby the remaining three components demonstrate inconclusive data. Bartlett’s Test of

Sphericity suggests a significant correlation ($p < .001$) in the data. Summing up, the groups revealed significantly individualistic and ambitious preferences with strong goal-orientation, what could influence the further course of the study and the gameplay.

4.2 Post-Game Questionnaires (T1)

Under the post-game questionnaire (T1) participants were asked whether they think that the game will change their future behavior. Possible answers were “If yes, in what way?” and “If no, in what way?” An inductive, qualitative approach was taken and resulted in various index terms that were identified from the answers given by all participants ($n=19$). Five students marked “yes”, 13 students “no” and one student abstained.

Firstly, data under the umbrella term “Economy” (**I1**) was identified. The term business was mentioned, and keywords such as “companies” were also included in the answers. It was mentioned twice that economics is incompatible with behavior change. Further, participants indicated that the economy does not work as shown in the game, overall negative thought patterns were dominating. All participants that included this index term in their answer also indicated “No”, as for whether they expect that the game will change future behavior. Related to that, one participant stated with a negative connotation, that the game was “far from reality”, and does not reflect how economic trade works. Therefore, we can assume that collaborative behaviour was perceived as less profitable, both in the game and in everyday life.

Four out of 19 participants included in their answers the topic of “prior knowledge” (**I2**). It was stated that the problem is already known, and that for example, the environment is already considered. Here, twice a positive thinking pattern underlined the overall answer given, whereby the remaining two participants mentioned prior knowledge in a neutral way. Thus, positive change would require either new setting or more engaging representation.

“Sustainability” (**I3**) was mentioned by three participants, whereby two indicated “yes” when asked whether playing the game will change their future behavior, and one indicated “No”. Under sustainability, the participants mentioned that there should be a greater focus on sustainable thinking, and that their knowledge was already present before playing the game. Overall, no clear change in behavioral intention can be linked to the index term “Sustainability”. Although participants were aware of the significance of sustainability, they did not link it to collaboration.

Moreover, “Not implementable” (**I4**) was mentioned by four participants and occurred within the context of strong negative connotation. One participant mentioned that it is in practice not realisable, in reference to acting more sustainable.

However, “collaborative thinking patterns” (**I5**) were recognizable in four participants. Three showed positive thinking patterns and also indicated “Yes” for the item on expected change in future behavior, while the participant that indicated “No”, provided a neutral statement towards collaborative thinking. The focus here took the overarching theme of collective behavior change, and communication. One out of the four participants noted that competitive thinking should be minimized.

4.3 Comparison between T1 and T2

The results were obtained using category-guided qualitative-oriented text analysis, which was derived from the open-ended responses in the pre-post debriefing questionnaire (T1 and T2). The responses in this questionnaire were analyzed using deductive categories, for which a coding guide was used. Since the simulation and the questionnaire were conducted in German, the evaluation was also done in German and the English translation was performed in the last stage.

Guided by Mayring’s (2010) process model for deductive category application, the methodological procedure is outlined below. First, the object and the research question are formulated. The general question refers to the changes of the players through the debriefing. The focus of the analysis is the hypothesis that debriefing is essential for the players to move from the

game level to the meta level. In the second step, the structuring dimensions are defined as categories. Regarding the hypothesis, the categories of game level and meta level are chosen. Regarding the learning objectives, the categories cooperation and competition are also included. In the third step, the categories are presented in a coding guide (see Appendix 2). In the next steps, the first categorizations and revisions will be made before the basis of the data is created in a final material run. The last step is the evaluation, which in this case is a simple frequency analysis and is shown below.

As the debriefing is considered as one of the most important elements, it is essential for the intended learning processes to transfer what was experienced from the game to reality. The evaluation of the questions about the recommendations of further rounds of games have shown on the game/meta level that only few transferred conclusions (reflection on the meta level) took place before the debriefing. While there were only 6 mentions on the meta level before the debriefing, there were 23 afterwards. In this context, the mentions on the game level also decreased from 42 to 32, although this value is difficult to classify without reference.

Of special interest is the increase of a cooperative strategy based on the debriefing. This could lead to the conclusion that the players would choose cooperative strategies in a further game run (or also in the transfer to similar situations in practice). While there were only 11 mentions before the debriefing, there were 25 afterwards. The low number of mentions of competing strategies can be neglected in this case.

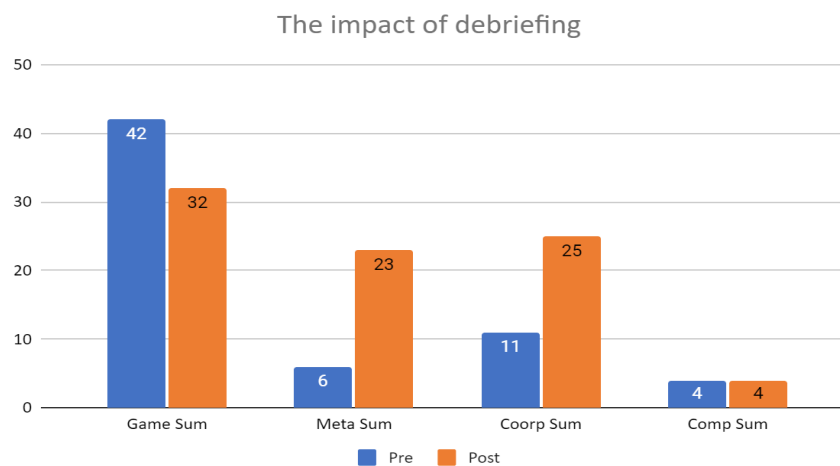


Fig. 6. The impact of debriefing.

5 Conclusions, limitations and future research

This study cannot report a congruent shift in opinion on the matter of collaboration for sustainable resource management. This is not in line with other research such as by McGrath *et al.* (2020), where hospitality students reported an improvement in understanding of the role of collaboration for sustainability matters after undergoing a teaching simulation game on sustainable practices in tourism. However, the students under this study were familiar with theories from hospitality management also involving sustainable practices. This stands in contrast to the logistics students in this research study, who were not educated on the particular matter. Hence, this kind of frontloading may explain the discrepancy of both studies.

The non-collaborative and unethical thinking patterns seen in this study may relate to a variety of factors. Firstly, openness to experience is associated with unethical behavior (Koodamra *et al.*, 2020). This trait is related to divergent thinking, the creation of new ideas, which in turn, relates to inventiveness (Nieß & Zacher, 2015). Hence, the high levels of inventiveness in this study may have contributed to the negative connotation in the thinking of the participants. Moreover,

low levels of agreeableness are seen in people that are unwilling to cooperate, which was seen in this study. This in turn negatively correlates with ethical behavior and may further explain the findings. Lastly, conscientiousness negatively correlates with unethical behavior (Koodamra et al., 2020). Since this trait scored low in this study, this might have promoted the positive correlation instead. As Platz (2020) suggests, anticipation of the challenges by effective game design, in this case with stronger impact on collaboration enhancement, could be beneficial.

The research outcomes can also be looked at from the perspective of personality traits. Research by Visser *et al.* (2011), for example, maps out traits of individuals in leading roles with strong sustainable thinking. An inclusive, collaborative, committing, and participatory style was associated with sustainable thinking. This can be complemented by an altruist worldview and a focus on the greater good of the community (Visser *et al.*, 2011). However, these traits were not strongly present in the participating student group, where we found a rather individualistic view. This shall explain the non-sustainable behavior patterns. Additionally, students that score higher on the scale of extraversion are more prone to engage in unethical behavior (Koodamra et al., 2020). In a study by Aydoğmuş and Koyuncuoğlu (2021), extraversion was positively associated with social capital. Hence, in this study, high levels of social capacity, and capacity to influence people can be seen as markers for extraversion. Overall, there might be a connection between the individual's personality traits and seen behavior patterns.

Furthermore, the overall consideration for sustainable practice was moderate to low in this study, while ambition was high. Although participants were aware of the importance of sustainability, they did not appreciate collaboration as one of its main prerequisites. The concept of “relative distance” may add to the understanding. “Relative distance” from a topic can reduce ambition for a certain goal but may increase it for other goals. There is a structural component to relative distance, which can be the field one is most involved in, which in this case is business studies and logistics (Keller & Zavalloni, 1946). This structural component may result in ambitious thinking under this structural component, but the relative distance to sustainability studies decreased ambition in the area of sustainable behavior.

Another explanation could be seen in the cultural dimension. Hofstede and Caluwe (2010) have cited unwritten laws regarding cultural biases of gamers as a meaningful determinant of a simulation games's success. Lukosch et al (2017), in examining cultural differences in gaming behavior, found German gamers with higher performance. With regard to the present study, the rationale for competitive gaming behavior could be considered in the cultural background of the gamers. Annotated that game performance has no impact on learning efficacy. In this case it opens up a question about game design driven by the character traits of future users: to what extent a designer should consider character traits and does it matter to measure them, if the game is dedicated to a specific group of people.

Although little cooperative behavior was observed in the game, an increased tendency toward future cooperative behavioral intentions is very much evident after the debriefing. In addition, this demonstrated the importance of debriefing. Without debriefing, the game is simply considered as such. Through debriefing, however, even an unsuccessful game could be seen as a learning opportunity for many players – whether they consider a change of disposition or not. However, as stated by Erhel & Jamet (2013) and confirmed by the study, the context of learning plays a vital role.

It was shown that the importance of debriefing is also confirmed in this study. Debriefing is essential to get out of the game world and create connections to reality. Without debriefing, it would have been merely a game with a missed learning opportunity. Overall, while playing the sustainability game did not influence the tendency to collaborate, it did raise participants' awareness of the importance of cooperation in managing commons.

This research was subject to several limitations. Firstly, the sample size of 19 is not strong enough to formulate generalizations. Similarly, conclusions and assumptions can only be drawn based on the context of students within the German educational system. This way, it cannot be transferred into other cultural contexts. In the same way, this study was conducted with a group

of students with a homogeneous study background, therefore findings cannot be assigned to students in general.

Consequently, the authors of this article plan to replicate this study in other cultural contexts, with a larger number of participants, and with students from various disciplines. This will add valuable data to further explore, understand, and confirm the findings of this study.

Another limitation in the paper lies in the nature of some closed questions and the short time frame. The question immediately after the simulation about a self-assessment about future behavior cannot provide information about an actual behavior. If students continue to talk about the findings after the simulation game, a change in behavior cannot be ruled out – in the context of this study, such could not be evidenced. It would therefore be interesting to ask students sometime after the simulation game in order to be able to speak of actual learning effects or behavioral changes.

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