Gamifying Sustainable Behavior at Work: Results from an Experiment with a Corporate Gamification App

Paul Clemens Morschheuser
Leipzig University
Leipzig, Germany *clemens.university@gmail.com*

Rainer Alt
Leipzig University
Leipzig, Germany *rainer.alt@uni-leipzig.de*

Stephan Sachse
VNG AG
Leipzig, Germany *stephan.sachse@vng.de*

Benedikt Morschheuser
FAU Erlangen-Nürnberg
Nürnberg, Germany *benedikt.morschheuser@fau.de*

Abstract

Society's increasing demand to protect the climate puts enormous pressure on companies of all sectors to reduce their CO_2 footprint. Besides strategic investments in more sustainable value creation, it is also essential that employees adapt their mindset, motivation, and behavior. However, measures to engage employees to change their behavior are rare. In recent years, gamification has gained popularity as an effective approach to influencing human motivation and driving behavior change. This paper provides an overview of existing research on the use of gamification to engage sustainable behavior and empirical results from an experiment with a gamified app to promote sustainable behavior in a mid-sized company. Data is collected from users of the app and extended with information about their personality traits according to the HEXACO and NEP scales. The results indicate that gamification does indeed appear to be a suitable approach to support sustainable behavior at work.

Keywords: Gamification, Sustainability, Game Design Element, Corporate Gamification, Sustainable Development Goals (SDG)

1. Introduction

Our society faces an urgent emergency that calls for immediate action: climate change. The global temperature is rising and is likely to destroy our environment as we know it. In order to counter the phenomenon, it is necessary to reduce our emission of CO_2 on a global and local level. Thus, companies are challenged to include ecological engagement in their performance objectives and improve the CO_2 footprint of their value creation. The pressure of the society and global economic standards, such as the Greenhouse Gas protocol, drives them to act more sustainable. However, besides the optimization of processes, investments, and machines, employee behavior is a key factor that influences a company's sustainability performance. Employees are responsible for the implementation of a company's strategic sustainability goals, their individual carbon footprint has an impact on the organizational CO_2 emissions, and organizations need to literate their employees in sustainable behavior to be able to achieve relevant certificates (e.g. ISO 14001) [3, 4], [9]. Therefore, organizations are seeking suitable means that can support sustainable transformation initiatives on a company-wide and individual level.

With over 2.2 billion gamers spending around 3 billion hours a week playing video games [24, 25], digital gaming has become an integral part of our culture and society. Inspired by the

recognition that games are particularly effective in invoking enjoyment, intrinsic motivation, and other related positive experiences [14], practitioners and scholars are increasingly turning to games and their specific design features when aiming to influence such psychological outcomes outside of traditional video game environments. They use game design elements (such as virtual competitions, point systems, badges, or team challenges) in non-game contexts with the aim to invoke gameful experiences, which is known as 'gamification'. Various studies indicate that gamification can indeed have positive effects on people's motivation in conducting specific activities and even influence the behavior of individuals [21]. Further, research suggests that gamification could be an appropriate means to support humanity in achieving relevant behavioral change toward acting more sustainably. For example, various existing studies indicate that gamification can engage people to consume more sustainably and use environmentally friendly mobility solutions [13], [32]. However, the design and the effects of gamified solutions for changing the behavior of employees at work have been less researched so far [20]. Therefore, this paper presents results from a review of the existing body of knowledge on the use gamification to engage sustainable behavior and an innovative gamified solution of an gamified app to increase sustainable behavior within a medium-sized company. Further, we present the empirical findings of an experiment with this app. This paper contributes to the existing research by providing novel insights into using game design elements to promote sustainable behavior at work.

2. Background

2.1 Gamification

Gamification refers to "*the use of game elements in a non-game context*" [7] in order to produce positive, i.e., 'gameful' user experiences, thereby invoking motivation and meaningful engagement that provide instrumental value [14], [17]. In other words, the aim of gamification is to generate psychological outcomes similar to those in games and support value-creating change, such as influencing behavior. During the last decade, gamification has been applied in various contexts [21], including education [29], health, sports, logistics, or crowdsourcing [28] – to name a few. Gamification has also found its way into companies and has, for example, been used to support employee training, foster employees' creativity and innovation, engage the use of corporate intranet applications or increase the performance of employees in specific activities [21]. However, little research that has focused on the gamification of sustainable behavior at work [12]. Existing research shows that designers of gamification approaches can draw on a wide range of elements, ranging from points, badges, and leaderboards to storytelling or role-playing features [19], [21]. A common design pattern of gamification is the use of game design features for goal setting in order to guide the user's behavior in an activity. According to Johnson and Johnson, goal structures can be either individualistic, cooperative, or competitive. Based on their theory, all three types of goal structures do provide different psychological outcomes and influence the behavior of individuals differently [18].

In an individualistic situation, the goals of the individuals are independent of each other. The accomplishment of an individual objective does not influence the other person's accomplishment of their goals. The user behavior is driven by individualistic goals and motives, independent of the goals of others. In gamification design, individuals in such situations are commonly rewarded just based on their own performance. An example could be the goal to achieve a badge that every individual player could reach regardless of the performance of other players [18].

In a cooperative situation, the goals of several individuals are positively correlated. Individuals achieve their goal (only) if other individuals with whom they cooperate also achieve their objectives. An example is a baseball game. If one team member of the baseball team wins, so do their team members [18].

In a competitive situation, goals are negatively correlated and an individual can only achieve their goal if others miss achieving their goals [18]. An example would be an athletic contest. All individuals trying to reach the first place but only one can get it [18].

There might also be situations in which individualistic, cooperative, and competitive

elements occur together. For example, a "*cooperative-competitive gamification features that provide motivational affordances for gameful experience based on groups, with positive goal interdependencies within and negative goal interdependencies between the groups*" [28].

When setting goals, however, it should not be neglected that goals should generally challenge the user, but not intimidate them. Goals should be achievable to promote commitment [22], [33]. Research by Kovisto and Hamri has shown that elements of game design have different motivational effects on individuals [22]. However, there is little research on the effects of different gamification approaches on sustainability behavior.

2.2 Sustainability

The United Nations recognized the urgency of the climate crisis within their 17 sustainable development goals (SDGs). Number 13 proclaims the fight against climate change and thus also the reduction of CO_2 emissions. The term sustainability includes many different scopes. In this paper, it is considered as environmental sustainability according to Alt [1]. Various research has shown the impact of CO_2 emissions on the greenhouse gas effect and the devastating consequences for the planet [5], [11], [23], [34]. Based on SDG goal #13, this paper examines the possibilities of gamification to engage employees in reflecting on their CO_2 footprint and adapting their behavior towards more environmentally sustainable behaviors.

2.3 Current State of the Research on Gamification for Sustainability

For the foundations of this research, a systematic review of the existing body of knowledge on the use of gamification to support sustainable behavior has been conducted. The database Scopus was used, which is one of the largest databases for scientific literature and includes publications from sources such as Springer, IEEE, ACM, and many other publishers. The literature research was conducted on 13.05.2021. For the search query, TITLE-ABS-Key (gamification AND sustainability) AND (LIMIT-TO (SRCTYPE, "j")) was used. The results included any permutation of the terms gamification and sustainability in the title, abstract or keywords of journals. The search was limited to the metadata (title, abstract and keywords) because an included text search was expected to relate to a large number of false hits. This search was only focused on journals, as these usually contain the highest quality research results.

Through the described filters, the search within Scopus found 82 publications. First, one duplicate was found and removed from the list, which resulted in 81 remaining papers. For categorization, taxonomies were created. All papers were clustered about their (I) mainly focused sustainability issue, (II) use of game design elements, and (III) aim of the gamification.

For cluster (I), the identified topics were further assigned to the 17 SDGs of the United Nations. The categories "none" and "other" were added for papers that do not covered any of the 17 SDGs or descriped approaches which could not clearly aligned with at least one of the 17 goals. Table 1 shows the final categorization. Each paper was assigned to one or more of the categories.

Next, we investigate if the papers used game design elements in their research or not (II). Papers got labeled with "yes" if they used game design elements according to the list of popular gamification affordances of Koivisto & Hamari [21], which include game design elements such as leaderboards, stories, levels, or badges. In 51 of all papers such gamification features were found. Finally, we categorized the aim of the gamification (III) inside the papers along 5 clusters: "Educate" compromise approaches that aim to teach or educate the users. The category "framework" was used for papers that presented a gamification framework. Papers that had the aim to influence the behavior got sorted into "influence behavior". The category "literature reviews" was used for papers that presenting literature research as their main contribution. The "non" cluster was used for work where the goal of gamification could not be clearly identified. Table 2 shows the results of cluster (III). Noticeable on the literature research was the high proportion of papers about sustainable tourism and the aim to educate through gamification to save electricity.

Table 1. Cluster (I) of the papers by SDGs.

Sustainable Development Goal	Papers counted
1. no poverty	0
2. zero hunger	0
3. good health and well-being	1
4. quality education	21
5. gender equality	0
6. clean water and sanitation	4
7. affordable and clean energy	0
8. decent work and economic growth	2
9. industry, innovation and infrastructure	3
10. reduced inequities	0
11. sustainable cities and communities	3
12. responsible consumption and production	25
13. climate action	**3**
14. life below water	0
15. life on land	0
16. peace, justice and strong institutions	3
17. partnerships for the goals	0
other	18
none	4

Concluding there were only three papers that examined gamification to influence human behavior towards sustainability and protection of the climate (SDG 13) and only two of them used gamification. Further, this review made clear that there is a gap in the investigation of using gamification to minimize CO_2 emissions. Only a few papers, such as the paper "*Exploring the potential of a gamified approach to reduce energy use and carbon emissions in the household sector*" investigate the potential of gamification to reduce CO_2 emission [13]. These trailblazing studies indicate that gamification can indeed optimize behavior toward reducing CO_2. The specific focus of using gamification to reduce the emissions of CO_2 in companies is hardly considered. However, several studies suggest that more research is needed in this field to guide companies in reducing their CO_2 pollution [15].

Table 2. Cluster (III) of the papers by aim of the gamification.

Aim of the gamification.	Papers counted
educate	22
framework	6
influence behavior	40
literature reviews	12
non	1

3. Developing an Enterprise App

An app named "Challenge4Future" was developed to study how gamification features could influence users in a corporate context to increase their sustainable behavior and reduce their CO_2 emissions, as well as to investigate the role of personality traits. The app was built for a medium-sized utilities company in Germany with about 1300 employees and a focus on natural gas trading, distribution and transportation.

A key objective was for the application to motivate users to start actively reducing CO_2 emissions and educate them about the impact of their individual CO_2 footprint on climate change. Further, we tried to achieve that the app is easy to use, which means that employees could easily insert their CO_2 saving behavior. The app was created with Microsoft Power Apps. According to Morschheuser et al. [27] and the survey of Du [8], the app was designed in close collaboration with a focus group of potential users, which tested the app regularly and gave feedback. These potential users were randomly selected from the entire workforce and consisted of 6 women and men between the age of 19 and 41. The final app version used in this study contained 13 pages, including settings, facts about sustainable behavior, a tutorial, a main menu, four sustainability challenges and a comprehensive set of game design elements (described below). The four sustainability challenges included different

areas where employees could reduce CO_2 emissions. The challenges compromised: (I) climate-friendly eating (eat), (II) avoiding the elevator and using the stairs (stairs), (III) avoiding printing to save paper (paper) and (IV) increasing the use of climate-friendly transportation (traffic). These challenges were chosen as, for instance, not traveling by car can save up to 2,4t CO_2 per year and a plant-based diet could save about 0,8t CO_2 per year [35]. Figure 1 shows a selection of app pages; From left to right: (A) A competitive ranking list for comparing CO_2 savings per user; (B) Overview of the personal and company's saved CO_2 emissions; (C) Page of the paper challenge.

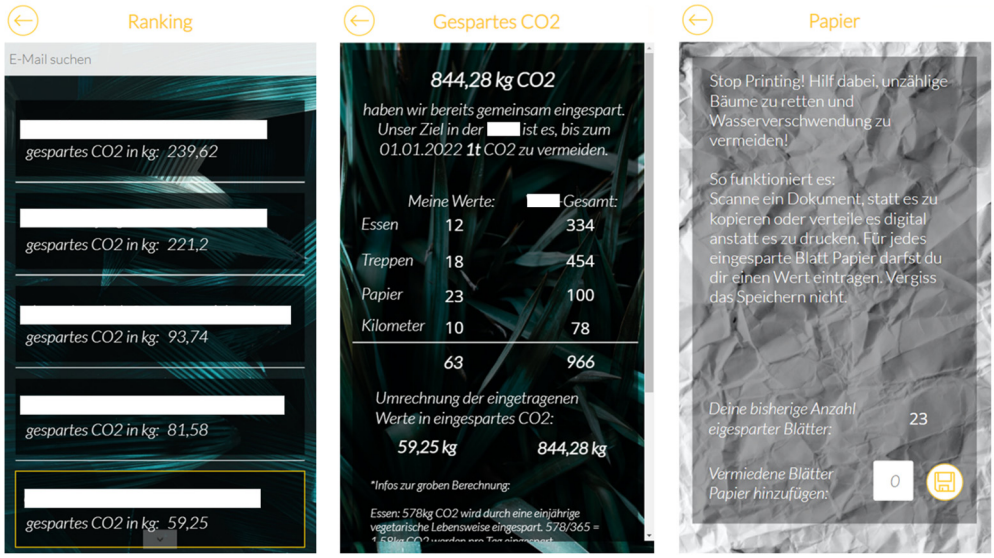

Fig. 1. Different types of sustainability challenges implemented in the app: (A) a competitive ranking list for comparing CO_2 savings per user (usernames have been redacted); (B) overview of own contribution in relation to a joint goal (company name redacted); (C) an individualistic challenge.

3.1 Game Design Elements

With the aim of influencing the employee's motivation to track and reflect on their sustainability behavior at work and to influence their actual behavior, we integrated established game design elements. An overview of the implemented elements is shown in table 3. By drawing on the methodology of Werbach & Hunt [33], which draws on the MDA framework of Robin Hunicke, Marc LeBlanc, and Robert Zubek [16], we describe each implemented gamification feature with their underlying game mechanic. The column mechanics describes the intended use and function of the element. Our application contains game design elements designed with the intent to act as elements that provide progress feedback, invoke competitions, provide rewards, clear individual goals, and shared goals to engage cooperation. Instant feedback was used to inform the user about his behavior and actual impact [33]. Badges were used to provide rewards that honor the user for his own performance. As described by Johnson and Johnson, there are three game mechanisms. We use all three to target different types of users, depending on whether they want to compete, cooperate, or achieve individual goals. Ranking appeals to competitive users, a shared goal (saving 1t altogether of CO_2 until one year) to the cooperatively interested, and levels and badges to the individual user types [18]. All game design features were designed to engage the app users to work on the four defined sustainability challenges. In the last column of table 3 we explain the logic of the used game design elements.

All these elements were used with the intention to get the users of this app into a so called "engagement loop". Werbach and Hunter emphasize the importance of selecting the right game design features that engage the user to repeated performance. For instance, they mention that:" *Player actions result from motivation and in turn produce feedback in the form of responses from the system, like awarding points.*" [33]. This feedback motivates the user to continue, which provides motivation and feedback again, and so on. Instant positive feedback is the key element, which makes games effective. The action of the user produces a direct visible response. "*Points, for example, are a way of displaying feedback about performance, as are*

leaderboards, levels, and achievements. Thinking in terms of feedback keeps you from overemphasizing the specific components or their reward aspects. A reward, after all, is just a kind of feedback. The feedback is what creates the motivation for further actions." [33].

In our app we aimed to realize engagement loops such as: 1. the user behaves sustainably; 2. the user enters his sustainable behavior into the app; 3. the user is rewarded by the game design elements in the app (e.g., by moving up in the ranking); 4. this motivates the user to behave sustainably again, which results in 1. With the intention of keeping user engagement high, we included challenges with increasing complexity for the users which offer the opportunity to experience continuous progress and mastery over time.

Table 3. Overview of the used game design elements.

Element	**Description**	**Mechanic**	**Example on how the elements were used to engage the app users towards the sustainability challenges**			
			Paper	**Eat**	**Traffic**	**Stairs**
Badges	Achievements are visualized with badges.	Reward	A Badge for saving 100 pages of paper.	A badge for manage to live vegetarian for 100 days.	A badge for using environmentally friendly means of transport over 100km.	A badge for taking the stairs at 100 floors.
Level	By saving CO_2, different levels can be reached in 200kg steps.	Feedback	The following levels can be unlocked regardless of the type of sustainable challenge. 1. Average person from 0kg 2. Environmentally conscious person from 200kg 3. Fridays for future activist from 400kg 4. Luisa Neubauer from 600kg 5. Mojib Latif from 800kg 6. Greta Thunberg 1000kg			
Points	The points give the player feedback for their behavior. Through this, the effect of the action can be understood.	Feedback	Get a point by avoiding a printed paper page. +1 Point	Receive one point for eating only vegetarian food in a day. +1 Point	Receive a point for every kilometer you ride your bike to work. +1 Point	Get one point for each floor you climb. +1 Point
Notifications	For entering values, the user receives unexpected motivational push notifications.	Feedback	For each sustainable challenge, a message is displayed at the 1, 25, 50, 75 and 100 entered values, which praises the user for his behaviour and motivates him to continue. For example: "*Hang in there! You're already over halfway to the Gandhi award.*"			
Quest	A predefined task which should be achieved. Due to the limited time, there is pressure on the participant.	Challenge	Save over 1t CO_2 in one year with all app participants.			
Ranking	Shows where users stand in comparison to others and promotes competition.	Competition	There is a general CO_2 ranking. The participants are ranked according to the number of CO_2 values they have saved. The ranking list can be viewed by each player.			
Saved CO_2	For each point collected, the value per category is converted into approximate CO_2 saved.	Feedback	One sheet of paper saves 0.006kg of CO_2, with 200 sheets it would be: +1.2kg CO_2	A purely vegetarian lifestyle saves 1.58kg of CO_2 per day. With 5 days this results in: +7.9kg CO_2	Driving a gasoline car emits about 4kg of CO2 per kilometer. For a commute of 7km it saves: +28kg CO_2	One elevator ride produces approximately 0.00872kg of CO_2. Walking 3 floors therefore saves: +0.02616kg CO_2
Team	The formation of a group to achieve a predefined goal together.	Cooperation	Save over 1t CO_2 in one year with all app participants.			

For instance, the first positive feedback was provided after submitting the first value input. To get further feedback, the user must continue to enter 24 value inputs. The complexity of the

designed gamification challenges was based on the level of difficulty of these tasks in reality. Eating only veggie products for 100 days takes 100 days and is difficult to achieve. Avoiding printing out 100 pages of paper could be achieved faster and walking 100 floors could be accomplished in a day. The combination of challenges with increasing complexity and engagement loops were used with the intention to achieve long-lasting motivation of the app user [33].

4. Experiment

4.1 Hypotheses

In this paper, we examine the potential of using gamification to motivate employees to reduce their CO_2 emissions and learn more about on the effect of their behavior on climate change. This study was guided by four hypotheses. H1 and H2 focus the effect of gamification on the sustainable behavior of employees. Hypotheses H3 and H4 examine the role of specific personality traits in this context.

Previous research has shown that gamification can positively affect people's motivation to participate in certain activities and can even influence behavior [21]. Therefore, we assume that gamification can also engage employees to use a sustainability app at work. Consequently, our first hypothesis is:

H1: Adding gamification to a sustainability app result in more frequent and engaged use of the app.

The hypothesis was investigated by analyzing the number of app openings of users with game design elements compared to users without. Further, the number of interactions of the users of the gamified app was compared with users who used the non-gamified app.

Our literature review revealed that little research exists that has investigated the potential of gamification to motivate people to optimize their CO_2 footprint. Gamification might be an appropriate means to increase a users' intrinsic motivation to track and reduce CO_2 emissions. This leads to hypothesis two:

H2: The use of game design elements will increase sustainable behavior.

The hypothesis was investigated by analyzing the user engagement with the sustainability challenges of the app.

Previous research indicates that personality traits can moderate the effects of gamification approaches [22]. Therefore, we have implemented different gamification features that may engage different user types. In detail, we had implemented cooperative, competitive and individualistic game design features [18]. Overall, preventing climate change is a challenge that requires cooperative efforts. It also requires altruistic behavior because the effects of individual behavior are imperceptible. Thus, we are interested in whether egoistic users could be engaged to behave sustainably with gamification that provides selfish outcomes, which leads to the third hypothesis.

H3: People with selfish personalities are more interested in competitive game design elements.

An already sustainable attitude implies an intrinsic motivation to behave in an environmentally friendly way in order to be true to one's own principles. An users' pro-environmental orientation could also have an impact on his motivation to use such a sustainability app. It could be assumed that people with an already strong environmental interest may see no personal benefits in the use of such an app and therefore use it less. By this assumption, the fourth hypothesis was formed:

H4: People with a high interest in the environment are less likely to use an app to motivate them to live sustainably.

To investigate hypotheses three and four, we clustered the users based on their answers from the survey on the NEP and HEXACO questionnaires and investigated their behavior in the app.

4.2 Measurements

During the use of the app, every interaction of the users was recorded as log data, for example the opening of app pages or the entry of specific values. With accepting the terms of use of the app, each user agreed on the storage of their data. Since the individual start dates of the users were different, we always analyzed the log data of the first 7 days from each user. To track the app users' pro-environmental orientation and personality, we asked the participants to fill a questionnaire with items from the New Ecological Paradigm (NEP) scale and the "Honesty-Humility" items of the HEXACO personality profile. The researcher Dunlap, Van Lier, Mertig and Jones developed the NEP scale to measure environmental concern and attitudes [10]. The NEP emphasizes the limitation of human intervention in nature, including through the preservation of the natural environment or population control. Since all our participants were native Germans, we used the German translation of Schleyer-Lindenmann et al. [30]. The HEXACO is a survey to measure six-dimensions of personality. It emerged from the reanalysis of the lexical study for the Big Five, another personality study. Typically, the HEXACO consists of 100 or 60 items. However, Vries's research found that the "Honesty-Humility" questions one of the six dimensions can be used to predict egoism [31]. This study uses 60 items, which leads to 10 questions on the dimension "Honesty-Humility". The developers of the HEXACO provide a valid translation in German, which is used to measure the egoism of the subjects.

4.3 Material

Two identical apps were created for the experiment "A" and "B". App "A", in contrast to app "B", has have implemented the game design elements mentioned above. In preparation, the subjects were randomly assigned into group 1 for app "A" and group 2 for app "B". An experiment following a between subject design was conducted with the two versions of the app. The data collection was started individually for each user at the moment when the users opened the app for the first time, then every interaction of the user within the app was documented for 7 days. After 4 weeks, the participants received an invitation to participate in a survey via email. This survey included items on age, gender, frequency of use of digital games, environmental orientation through questions from the New Ecological Paradigm, items measuring selfishness through questions from the HEXACO, questions on players fairness, perceived enjoyment of using the app, perceived usefulness of the app, and a field to provide general feedback on the app. Most of the items were taken from previous research [2],[10],[26].

5. Results

5.1 Participants

The app was designed and developed within the stated company. The acquisition of the participants took place through an intranet message. The sample consisted of 13 male and 11 female subjects between 23 and 62 years old. The subjects were working students and full-time workers. On average, they played digital games rarely to monthly. The attitude towards ecology was on average slightly more positive than neutral. According to HEXACO, the users were more egoistic on average. The distribution of the control variables was checked for differences between group 1 and group 2 using Pearson's chi-square test in cross-tables. No significant dependence was found for gender, frequency of playing digital games, NEP or HEXACO. All determined p-values were greater than 0.05, so that the null hypothesis "*The two variables A and B are independent of each other."* could not be disproved. Thus, the sub sample represents a good condition for proving the hypotheses H3 and H4.

5.2 Hypothesis Testing

To examine H1, the number of app openings between group 1 and group 2 have been considered. Due to the sample size and since the data was not normally distributed, a non-parametric Mann-Whitney-U test was applied to investigate potential differences between the groups. The test showed no significant difference. Nevertheless, the direct comparison of the

collected data revealed that sum of app openings in one week was higher in group 1 (arithmetic mean of 1.45, standard deviation 1.04) compared to group 2 (arithmetic mean of 1.38, standard deviation 0.96). In addition, users in group 1 (arithmetic mean of 20.55, standard deviation 17.94) visited more app pages in one week compared to group 2 (arithmetic mean of 15.31, standard deviation 10.49). This indicates that a tendency that users with gamification features opened and the app in general more often than users without gamification and it can be concluded that the number of interactions in an app with game design elements is higher than in one without.

The second hypothesis H2 refers to a difference in the behavior of the app users. Due to the scattering of the values and the number of extreme values, it was not possible to perform a T-test to confirm the difference in the mean values significantly. Therefore, a significant confirmation of this hypothesis was not possible. However, a tendency could be described by closer examination of the values. The results of table 4 shows that, in the category paper, group 1 opened the challenge less frequently but entered more values than group 2. In the category traffic, group 1 opened the challenge more frequently but added fewer values than group 2. In the category stairs, group 1 entered more values despite having opened the challenge less frequently than group 2. In the eat category, group 1 opened the category more frequently and entered more values. In conclusion, this hypothesis cannot neither be significantly confirmed nor rejected. However, a tendency could be seen that despite a partially lower interest in the category, more values were saved by users with game design elements. It is also evident that group 1 tends to have more extreme values than group 2, such power user according to Craddock [6].

Table 4. Results for the second hypothesis.

Category	**Arithmetic mean**		**Standard deviation**	
	Group 1 (N=11)	**Group 2 (N=13)**	**Group 1 (N=11)**	**Group 2 (N=13)**
Paper opened	0.73	1.31	0.79	1.38
Paper saved	12.82	1.62	36.05	3.15
Traffic opened	1.55	1.23	2.88	0.83
Traffic saved	1.82	3.62	6.03	7.04
Stairs opened	1.36	1.54	1.43	1.45
Stairs saved	33.82	1.85	90.37	3.72
Eat opened	2.09	2.00	1.51	1.63
Eat saved	16.45	11.69	44.42	38.57

Hypothesis 3 deals with the influence of game design elements in different characteristic properties. To investigate this hypothesis, we could only look at the people in the first group, since they had game design elements in their app. Since the sample size is 9, $n<30$, no T-test for a difference in means could be made. When performing the Mann-Whitney-U tests, no significant difference could be detected. A closer look at the median and arithmetic mean values was not meaningful since the first HEXACO group consists of only 2 persons and the other group of 7. Thus, no statement could be made regarding this hypothesis. The few data indicated that people with an egoistic personality used the app more often.

The last hypothesis H4 deals with the interest of the environmental advocates in relation to an app for saving CO_2. The group size was 14 thus $n<30$. Therefore, the test for a ormal distribution for the subsequent hypothesis T-test was not meaningful. Nevertheless, a tendency could be described with the results of table 5. Those users with a more environmentally friendly attitude (NEP score between 3-5) have used the app less and, accordingly, had a lower interest in the app, then persons with a less pro-ecological attitude (NEP score between 1-3).

Table 5. Results for the fourth hypothesis.

Category	**Arithmetic mean**		**Standard deviation**	
	NEP 1-3 (N=3)	**NEP 3-5 (N=4)**	**NEP 1-3 (N=3)**	**NEP 3-5 (N=4)**
Quantity app opened in one week	1.83	1.38	1.33	1.06
Quantity page traffic in one week	22.83	18.38	22.57	14.02

6. Discussion and Conclusion

This work investigates the use of gamification to promote sustainable behavior at work and contributes to the increasing number of research in this field. The existing body of knowledge (mainly three papers cf. [13], [15] and [32]) focused primarily on the effects of game design elements for eco-friendly behavior. This study adds to these existing studies by comparing the effects of a gamified and non-gamified application for engaging sustainable behavior of employees in an empirical experiment.

The findings show tendencies that the use of game design elements increases the usage frequency of the investigated app for sustainable behavior. People with game design elements in their app are more likely to open the app compared to people without game design elements. This result is in line with previous research that compared gamification and non-gamified approaches in related contexts, such as crowdsourcing, education or sports [21]. Furthermore, a tendency for more environmentally friendly behavior is found when comparing both app versions with game design elements and without. Although we were not able to identify significant effects due to the small sample size, the results indicate that gamification may indeed be able to support organizations in engaging their employees to reflect on their sustainable behavior at work and change their behavior.

Previous research has shown that gender and personality characteristics can influence the effects of gamification approaches. The present study indicates that both genders had the greatest interest in the competitive element. Furthermore, the interest was higher for men in the individual element than in the cooperative elements. For the women, it was the other way around. They found the cooperative the second most interesting and the individual was in third place. The women showed more interest in the game design elements than the men in a direct comparison. The women have had a higher interest in the competitive and cooperative elements than the men. On the other hand, the men found the Individuals more interesting than the women. These findings add to previous research of Kovisto and Hamari [21] and support their finding that gender can moderate the effects of gamification. Compared to previous research about influencing sustainable behavior through gamification, this study confirmed that gamification using game design elements such as leaderboards, challenges, and direct feedback promotes sustainable behavior [33] and also tends to increase usage. Research on the app Ant-Forest has shown that the app is used because of the interest in sustainable behavior and not because of the enjoyment [32]. This statement correlates with the fact that people who are more sustainably oriented are less likely to use an app to promote sustainable behavior because they are already behaving sustainably. Furthermore, prior research has found that cooperative game design elements work better at promoting eco-friendly behavior than competitive ones. This statement should be relativized, as this research has shown that the effect of game design elements depends on the individual, as shown by Kovisto and Hamari [21]. In conclusion, it can be demonstrated that the use of game design elements is useful to motivate people to protect the environment.

From an industry perspective, gamification is a suitable means of encouraging employees to increase their awareness of the issue of sustainability and to influence their sustainable behavior at work. The study suggests using different design features to address cooperative, individual and competitive motivated employees. Especially for the company that participated in this study, it became clear that cooperative goals appealed to the employees the most. During the experiment, the subjects saved an estimated 863.01kg of CO_2 emissions. It has been shown that the usability of an app should be as simple as possible in order not to create additional barriers. Furthermore, external stimuli such as possible prizes for the use of the app could inspire success. User feedback showed that the users wished for additional audio feedback, the automatic recording of behavior and storytelling. During the development, we learned that the regulatory framework of a company should be considered and the involvement of the works council is important to ensure the acceptance and success of such an app. Further, support from the management is important. The management should recognize the environmental performance of the employees.

Overall, this work demonstrates the potential of gamification for supporting sustainable behavior at work. However, more research needs to be conducted to prove the tendencies found in this study. Especially, personalized gamification approaches that use individual game design

elements for different user types may provide additional potential to further engage desired behavior in the direction of more environmental behavior at work. Additionally, long-term studies should be conducted. We hope that our approaches and results will inspire other researchers to promote the further investigation and use of gamification as a possible contribution to saving our planet earth.

References

1. Alt, R.: Electronic Markets on sustainability. Electronic Markets 30, 667-674 (2020)
2. Ashton, M.C., Lee, K.: The HEXACO-60: A short measure of the major dimensions of personality. Journal of Personality Assessment 91, 340–345 (2009)
3. Ashwin K. N. C., Smith, C., Badis, L., Wang, N., Ambrosy, P., Tavars, R.: ESG factors and risk-adjusted performance: a new quantitative model, Journal of Sustainable Finance & Investment 6 (4), 292-300 (2016)
4. Chen, Y., Tang, G., Jin, J., Li, J., Paillé, P.: Linking Market Orientation and Environmental Performance:The Influence of Environmental Strategy, Employee'sEnvironmental Involvement, and Environmental Product Quality, Journal of Business Ethics 127 (2), 2014
5. Ciais, P., Sabine, C., Bala, G., Bopp, L., Brovkin, V., Canadell, J., Chhabra, A., DeFries, R., Galloway, J., Heimann, M., Jones, C., Le Quéré, C., Myneni, R.B., Piao, S., Thornton, P., 6, in: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Hrsg.): Climate Change 2013: The Physical Science Basis. In: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (27), pp. 465–570. IPCC, New York (2013)
6. Craddock, G.: The AT continuum in education: novice to power user, Disability and rehabilitation. Assistive technology, 1, 17–27 (2006)
7. Deterding, S., Dixon, D., Khaled, R., Nacke, Lennart.: From Game Design Elements to Gamefulness: Defining "Gamification". In: Proceedings of the 15th International Academic MindTrek Conference Envisioning Future Media Environments, (2011)
8. Du, H. S., Ke, X., Wagner, C.: Inducing individuals to engage in a gamified platform for environmental conservation. Industrial Management and Data Systems, 120(4), 692-713 (2020)
9. Dunker, J., Olugunna, M., Corporate Environmental Responsibilities (CER): A case of Logistics Companies in Sweden, Dissertation (2014)
10. Dunlap, R.E., van Liere, K.D., Mertig, A.G., Jones, R.E.: New Trends in Measuring Environmental Attitudes: Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale, Journal of Social Issues 56 (3), 425–442. (2000)
11. Friedlingstein, P. et al.: Global Carbon Budget, Earth System Science Data 11 (4), 1783–1838, (2019)
12. Galeote, D., F., Rajanen, M., Rajanen, D., Legaki, N., Z., Langley, D., J., Hamari, J.: Gamification for climate change engagement: review of corpus and future agenda, Environmental Research Letters 16 (6), (2021)
13. Gangolells, M., Casals, M., Macarulla, M., Forcada, N.: Exploring the Potential of a Gamified Approach to Reduce Energy Use and Carbon Emissions in the Household Sector, Sustainability 13 (6), 3380 (2021)
14. Hamari, J.: Gamification, Blackwell Encyclopedia of Sociology, Tamper University Finland, (2007)
15. Henn, F., Kluge, S.: Play it Green! – Konzeptionelle Entwicklung und Design eines Gamification Prototyps zur Motivation von umweltbewusstem Verhalten innerhalb eines Unternehmens, HMD Praxis der Wirtschaftsinformatik 58 (1), 134–154 (2021)
16. Hunicke, R., LeBlanc, M., Zubek, R.: MDA: A Formal Approach to Game Design and Game Research, (2004)
17. Huotari, K., Hamari, J.: A definition for gamification: anchoring gamification in the service marketing literature, Electronic Markets 27 (1), 21–31 (2017)
18. Johnson, D.W., Johnson, R.T.: Instructional Goal Structure: Cooperative, Competitive, or

Individualistic, Review of Educational Research 44 (2), 213 (1974)
19. Kapp, K., M.: The gamification of learning and instructions, San Francisco, (2012)
20. Krath, J., Morschheuser, B., Korflesch, H., F., O., v.: Designing Gamification for Sustainable Employee Behavior: Insights on Employee Motivations, Design Features and Gamification Elements. In Proceedings of the 55th Hawaii International Conference on System Sciences, pp. 1594-1603. Hawaii, USA (2022)
21. Koivisto, J., Hamari, J.: The Rise of Motivational Information Systems, International Journal of Information Management 45, 191-210 (2019)
22. Koivisto, J., Hamari, J.: Demographic differences in perceived benefits from gamification, Computers in Human Behavior 35, 179-188 (2014)
23. Latif, M.: Heißzeit, Herder, Freiburg, Basel, Wien, (2020)
24. McDonald, E.: The global games market will reach $108.9 Billion in 2017 with mobile taking 42%, Newzoo, (2017)
25. McGonigal, J.: Reality is broken: Why Games Make Us Better and How They Can Change the World , Vintage, London, (2012)
26. Morschheuser, B., Hamari, J., Maedche, A.: Cooperation or competition – When do people contribute more? A field experiment on gamification of crowdsourcing, International Journal of Human-Computer Studies 127, 7–24 (2019)
27. Morschheuser, B., Hamari, J., Werder, K., Abe, J.: How to Gamify? A Method For Designing Gamification, In Proceedings of the 50th Hawaii International Conference on System Sciences. Hawaii, USA, (2017)
28. Morschheuser, B.: The gamification of crowdsourcing systems: Empirical investigations and design, Karlsruhe, (2017)
29. Munday, P.: Duolingo. Gamified learning through translation, Journal of Spanish Language Teaching 4 (2), 194-198 (2017)
30. Schleyer-Lindenmann, A., Ittner, H., Dauvier, B., Piolat, M.: Die NEP-Skala – hinter den (deutschen) Kulissen des Umweltbewusstseins, Diagnostica, 64 (3), 156–167 (2018)
31. Vries, R.E. de, Vries, A. de, Hoogh, A. de, Feij, J.: More than the Big Five: Egoism and the HEXACO model of personality, European Journal of Personality, 23 (8), 635–654 (2009)
32. Wang, X., Yao, X.: Fueling Pro-Environmental Behaviors with Gamification Design: Identifying Key Elements in Ant Forest with the Kano Model. Sustainability 12 (6), 2213-2230 (2020)
33. Werbach, K., Hunter, D.: For the win, Wharton Digital Press, Philadelphia (2012)
34. Woodward, F.I.: Global climate change, Acad. Press, London (1993)
35. Wynes, S., Nicholas, K.A.: The climate mitigation gap: education and government recommendations miss the most effective individual actions, Environmental Research Letters, 12 (7), 74024 (2017)