Teaching Sustainability through Gamification: An Empirical Study with Student Perspectives in Vocational Education

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Abstract

This contribution empirically examines the teaching of sustainability competencies through the use of gamification elements in vocational education. The study focuses on innovative ideas from current students regarding the targeted application of gamification elements to effectively convey sustainability in vocational training institutions. As part of the study, a survey was conducted among students from various degree programs at Mittweida University of Applied Sciences to gather innovative and forward-oriented ideas. In the investigation, students assumed the roles of both trainers and trainees and responded to practice-oriented questions. The literature review provides a foundational overview of sustainability, competencies, and gamification, summarizing the current state of research as well as existing research gaps. The findings indicate that, according to the students, well-implemented gamification elements can promote the development of sustainability competencies and should therefore be integrated into training programs. The results offer insights into gamification elements that, from the students' perspectives, are particularly effective for teaching sustainability and can simultaneously foster both intrinsic and extrinsic motivation among trainees. In conclusion, the contribution provides an outlook on potential future developments. The outlook also highlights that this research area remains underexplored, especially compared to the use of gamification elements in higher education for teaching sustainability. Furthermore, it emphasizes that there may be an increasing need for scientific engagement with the topic, particularly to explore more specific areas such as the inclusion of individuals with disabilities in this context.

Keywords;

Gamification, Student Perspectives, Sustainability, Teaching Methods, Vocational Education

I.   INTRODUCTION

The world population has increased dramatically in recent years. In 2025, the global population is estimated to be 8.23 billion people, compared to 7.79 billion in 2020 [1]. Between 1950 and 2000, the population increased tenfold. Technology, access to unlimited resources, and unlimited opportunities contribute to the continuously increasing prosperity. However, the finite availability of resources pushes the system to its limits. The "struggle for water, land, raw materials, air" [2] and the constant struggle for wealth among the population are some of the many reasons that are pushing the ecosystem to its breaking point. Human intervention in the complex and interconnected

ecosystem brings with it many unforeseen effects, whether positive or negative. [1] [2]

One area of the sustainability goals involves "ensuring the ability of present and future generations to act and develop" [2]. This is linked to an intergenerational sustainability concept, in which the inclusion of questions concerning sustainability has only been addressed in vocational training in recent years [3].

Yet despite the existence of sufficient concepts, initiatives, and models for implementing a sustainable economy, sustainable education has scarcely been established in vocational institutions. This raises the fundamental question of what possibilities can be introduced to address "the topic of sustainability in vocational schools" [4] and consequently, how these could ideally be brought closer to trainees.

II. OBJECTIVES

This study addresses the optimization of imparting sustainability competencies using gamification elements in vocational training settings. To prepare an optimization process, the first step was to evaluate which gamification elements are most effective for teaching sustainability. To provide information about process optimization, it is necessary to first explain the current state of research regarding sustainability in vocational institutions. To ensure further specification in relation to vocational training centers, the status quo section also includes explanations of the terms sustainability, competencies, and gamification as they relate to this subject area.

However, to conduct an accurate analysis of the current state of research regarding vocational training institutions and the teaching of sustainability, it is first necessary to define the term sustainability more precisely.

Sustainability can be applied in many different ways across various fields, such as energy, art, design, nutrition, or climate protection. For this reason, the term itself can sound rather vague and abstract without a precise definition, as it is used by everyone for different purposes[2]. The term 'sustainability' first appeared in 1713, focusing on the exploitation of forests through tree felling. Even up to the nineteenth century, the term was used exclusively in connection with forestry. The first universally applicable definition for the areas of economy, ecology, and society was provided in 1987 by the WCED – World Commission on Environment and Development – in their report "Our Common Future". In this report, sustainability is described as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs and to choose their way of life". [5] This definition will be used throughout this contribution.

Sustainability includes, among other things, a concept for sustainable development, the aim of which is "socially, economically and ecologically sustainable development" [6]. In order to achieve such development, a total of 17 global sustainability goals were defined in 2015. These are addressed to science, the private sector, society, as well as governments worldwide. In addition to the goal of producing and consuming sustainably, the objectives also relate to global climate protection and worldwide access to education. The German implementation strategies for all 17 SDGs were further developed in January 2025, with the focus placed, among other things, on the

transformation areas of "human well-being and capabilities, social justice, energy transition and climate protection". [7]

Depending on which area of sustainability is addressed, these contain different key competences. For example, in the transformation area of "human well-being and capabilities, social justice", vocational education and training should primarily teach future competences for sustainable development and its implementation, as well as the associated challenges. [8]

At the same time, the National Committee of the UN Decade of Education for Sustainable Development provided a catalogue for the implementation of sustainability in vocational education. There it is evident that subject and methodological competence, social competence, and self-competence are crucial for successful implementation. [9]

The objective of vocational education is to acquire professional action competence, which consists of technical, social, and personal competence. Throughout the teaching and learning process, all these competencies should be imparted. At the same time, the aim of teaching sustainability is to develop and convey "sustainability competencies". The specific competencies used for this are the subject of considerable debate. There are several clarifications of the term, such as those put forward by the Orientation Framework for Education for Sustainable Development. These include, under the term sustainability competence, for example, systemic and networked thinking or communication and counselling skills. In the end, it is advisable to orient oneself to the sustainability triangle with its three pillars: social, ecological and economic. The learning content plays a central role in transferring these competencies and

should therefore reflect the three pillars. As sustainability is a complex topic, a complex learning subject better mirrors the field of study. [4]

To determine whether gamification elements would be advantageous in training, the next section will take a closer look at gamification and its elements.

Gamification is increasingly regarded as a tool to foster motivation and engagement across various aspects of life. In this context, elements like those which are found in video games are intended to be linked with aspects of everyday life, so that they exert a positive influence on individuals subconsciously and indirectly. The main focus by using gamification is to promote and maintain motivation in all possible life situations. Motivation can take intrinsic and extrinsic forms. For motivation through gamification, there is the so-called self-determination theory, which states that "three psychological basic needs must be fulfilled for intrinsic motivation". These are the needs for autonomy, competence, and social relatedness. [10]

However, in order to make a clear distinction between gamification and other terms such as 'serious games' or other types of games, this can, among other things, be done "by considering the aspect of gameplay". Here, a difference is made in that serious games possess an actual game flow, whereas in the case of gamification, this is rather blurred. At the same time, there is another distinction in that gamification is integrated into products or processes, whereas serious games can also exist independently. Thus, it becomes clear that gamification is primarily 'used', while serious games can be 'played'. Further differentiation from other terms is provided by Fig. 1. [11]

Fig. 1 shows two distinctions. The type of play differentiates between 'Paidia' and 'Ludus'. The term Paidia is Greek and refers to children's play or unstructured play, while Ludus is rule-based and has goal-oriented characteristics. The second dimension is 'completeness' and 'elements'. This distinguishes whether individual game elements are used or whether a comprehensive game is present. If gamification is now seen as a "description of the design process with game design elements in a non-game context", it follows that it is classified within the area of game elements, including rule-based games. This gives rise to the problem that the distinction between serious games and gamification is not entirely clear, meaning the boundary at which the transition occurs cannot be precisely defined. [11]

The current state of research about gamification indicates that above all, game-based elements enhance motivation. Some authors supplement the term gamification with 'meaningful' or 'reward-based' to better define the respective type of motivation. While reward-based gamification targets extrinsic and short-term motivation, meaningful gamification aims to "create optimal conditions for the emergence or fostering of long-term, intrinsic motivation". [11]
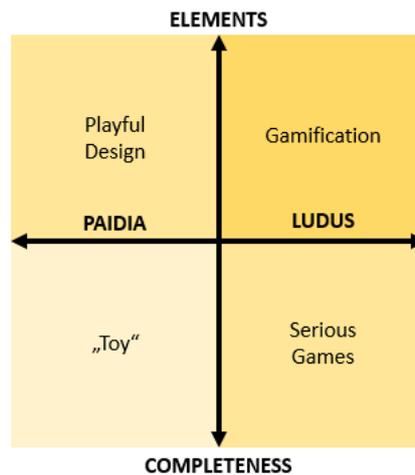

Figure. 1 Differentiation of gamification [12]

III. METHODS

A. Development

The importance of sustainability in the corporate sector has continued to grow in recent years. For this reason, it is crucial to integrate sustainability as a subject area into training institutions and to effectively introduce it to trainees. The aim here is the long-term retention of knowledge through the use of gamification elements, in order to enable motivation for knowledge acquisition. [12]

Education plays a significant role in shaping society to be "ecologically sustainable, economically productive, and socially equitable". For the successful integration of sustainable development into education, it is necessary for everyone to develop an awareness of how to incorporate and implement a sustainable economy in both their everyday and professional lives. With regard to businesses, this means that they require employees who have been trained in sustainable development. This responsibility falls not only to secondary and vocational schools, but especially to higher education

institutions. Thus universities are responsible for equipping employees with the necessary educational content and "supporting the economy with sustainable and competence-building learning concepts". Throughout this process, the concept of sustainability must be considered at all times. [13]

After research into the current state of knowledge regarding the use of these topics in vocational training institutions, it was found that while initial approaches and concepts for knowledge transfer do exist, the issue lies in their implementation. There are various ways in which sustainability can be passed on, but how this could be incorporated into vocational training in an innovative and playful manner by trainers has rarely, if ever, been researched. For this reason, the present paper aims to provide a first approach to this topic. Initial ideas will be outlined as to how vocational training institutions could design their curricula more innovatively in the future and include sustainability as a topic.

Many academic publications have primarily focused on combinations of the three concepts - gamification, training, and sustainability - though rarely do all three topics appear together in synergy. Various works mention playful elements, but hardly ever gamification explicitly. For example, the scholarly work 'Gamification and Game Based Learning for Vocational Education and Training: A Systematic Literature Review' by Dahalan, Alias, and Shaharom demonstrates a connection between gamification content and training, but does not address sustainability or how this could be integrated with gamification in educational institutions. [14]

With regard to the general use of gamification, some aspects of which could potentially be applied in a corporate setting, Hamari, Koivisto & Sarsa published their work in 2014 entitled 'Does Gamification Work? — A Literature Review of Empirical Studies on Gamification'. This publication specifically addresses this topic, but again, only in relation to gamification and not explicitly to sustainability. [15]

Initial studies on the key competencies requirements for trainers seeking to impart sustainability and related strategies within companies can be found, among others, in the contribution by Frau Hufnagel and Annen titled 'Sustainability in Company Training – Competencies Requirements from an Entrepreneurial Perspective'. In this article, a competencies model is presented which discusses various aspects of trainers' professional competencies, based on a total of 22 expert interviews. This contribution provides an initial foundation for the teaching of sustainability in training companies. However, the integration of gamification elements was not the focus here. [16]

B. Evaluation

With regard to the preparation of the evaluation, the initial focus was on the formal implementation, which could achieve the greatest possible success based on various metrics. The aim of the survey was to record different approaches between vocational training institutions and their communication of sustainability topics in connection with gamification. In this context, the target group was to consist of doctoral students and students from different faculties at Mittweida University of Applied Sciences. Students were chosen as the target group because, in this way, new and innovative ideas from the current generation could be utilized to better integrate gamification into the teaching of sustainability. Ideally, at least 50 participants should take part in the survey; for this

reason, oral interviews as a survey method were excluded due to the excessive effort involved.

The consideration to select students as the target group arose from statistics showing that, in recent years, there have been more students than trainers. For this reason, it is possible that more students will be trained as trainers after graduation in the future. [17]

For the general structure of the survey, various answer options were used, each best suited to the respective questions. These options mainly consisted of so-called Likert scales, which contained different answer choices depending on the question. All in all, there were always five levels, so that participants had the option of giving a neutral response.

For necessary personal questions such as the current degree programs being attended, the students were given corresponding answer options from which they could choose. In total, the students and doctoral candidates received 16 questions. The questions were divided into five sections, each addressing a separate topic area. The first two sections covered data protection as well as personal details such as the faculty to which they belonged and their gender. The following section related to the students' existing knowledge on the topics of gamification, sustainability and the concept of competence. In addition, it addressed the teaching of sustainability competences and whether these should be delivered within subject-specific or cross-disciplinary courses.

The fourth section focused on gamification in connection with sustainability. Here, the students were asked to decide which gamification elements they considered the most innovative for conveying sustainability. At the same time, questions were posed regarding the extent to which practical skills around sustainability could be acquired with these elements, as well as a brief decision question on whether gamification increases motivation to engage with sustainability topics.

Finally, in the fifth section, the students were asked to focus on the topic of sustainability in vocational education and to consider which gamified learning offerings would motivate them in this context. Furthermore, the questions addressed what the participants saw as the main challenges associated with the integration of gamification, as well as which gamification elements they would most like to see included in training programs and which ones they would use themselves if they were trainers.

All data were collected using the Mittweida University of Applied Sciences survey tool and stored internally. The survey was made publicly available for two months, allowing as many responses as possible to be gathered through multiple invitations to enable a robust evaluation of the results. The students were expected to answer all the questions and then submit their assessment. Each question also included a button that allowed respondents to indicate that they did not wish to comment on the respective question. By allowing multiple answers, it was ensured that more data and results could be obtained for the respective questions.

IV. RESULTS

In total, 47 students and doctoral candidates completed the survey, thereby almost reaching the minimum target of 50 participants. Additionally, a total of eleven students discontinued filling in the questionnaire but did answer the questions up to and including sections three or four. For this reason, there are responses to all

questions including section three from 58 participants and including section four from 53 participants. Section five, by contrast, contains the previously mentioned 47 responses.

In the following section, the respective results of sections two to five will be presented, analyzed and subsequently evaluated.

Students from various faculties and degree programs participated in the survey. In addition to the faculties of Computer and Biosciences, Media, and Engineering Sciences, most students came from the Faculty of Social Work. The Faculty of Media was the least represented, with only one participant, and none of the students identified as coming from Industrial Engineering. The proportion of female students was higher, while less than half were male or chose not to disclose their gender.

Section three showed that 36 people were 'not at all' or 'barely familiar' with the term gamification, whereas only two people were unfamiliar or barely familiar with the terms sustainability and competence respectively. The majority were 'somewhat' or 'very familiar' with both terms, and only one person did not respond to the questions.

The survey results regarding whether sustainability competencies or other key competencies should be taught in a subject-specific or cross-disciplinary manner are predominantly neutral. For sustainability competencies, 20 responses were neutral and a total of 16 voted for 'somewhat cross-disciplinary.' For key competencies, there were a total of 15 neutral responses and 14 students who answered 'subject-specific.'

The fourth section contained seven questions and was therefore the most extensive section. In response to the question of which UN Sustainable Development Goals could be effectively conveyed through gamification, 32 participants agreed on sustainable consumption and production. Other areas that received 28 and 27 votes, respectively, were climate protection measures and health and well-being.

Regarding the question of whether practical skills for sustainability can be taught through gamification, 25 out of 53 respondents gave a rating of 'somewhat good'. Twelve each rated it as 'very good' or were neutral, while the remaining four students assessed it as 'somewhat poor' however, no one selected 'very poor'.

Only a few individuals mentioned specific games or apps with a reference to sustainability. Some answers referred to screen-time apps that promote the planting of trees, or the application 'Too Good To Go' concerning food waste, as well as games like City Skylines.

Out of 52 students, 31 agreed that gamification would increase motivation to engage in sustainability topics, while 18 were unsure. These results are related to the question of how important it is for students that gamification elements in training are designed to be interactive and playful. Here, too, of a total of 53 participants, 15 students each responded neutrally or said it was 'very important'.

The Fig. 2 presents the results of the question regarding which gamification elements students consider to be the most innovative for conveying sustainability topics. Multiple answers were possible.

Fig. 2 shows the responses of a total of 89 people who either successfully completed the survey or discontinued it beforehand. The majority of respondents primarily mentioned cooperative games

and reward systems, which are consistent with the results of the question regarding preferred elements in training programs. Point systems and solving various tasks within a team were also frequently cited.

Another area of focus was the effective delivery of sustainability competencies using gamification elements, to examine whether these differ from the innovative gamification elements previously mentioned. It can be said that, among the most effective elements, the concept of cooperative games and reward systems each received 29 votes, closely followed by storytelling and simulations with 24 votes. In contrast to the innovative elements, storytelling received more votes in this context, but the other three elements achieved the highest approval ratings in both questions.

The fifth and final section contained a total of six questions and primarily included open-ended responses rather than Likert scales.

Another aspect of the study focused on the factors that would motivate participants to take part in a learning program on sustainability. Here, a few individuals specifically stated that their motivation stemmed either from the desire to gain knowledge or from the prospect of receiving a benefit. The benefit mentioned referred for example to extra points for exams or additional marks. Another factor is the choice of topics, which should be transferable to real-life situations or offer sustainable applications in order to highlight their relevance. Additionally, some participants indicated that they would prefer to complete the learning program in a group setting to maintain their interest and motivation throughout the learning process.

The inclusion of group work was supported by the third figure, in which 35 students indicated that they would feel particularly comfortable within a group work environment when the topic of sustainability is conveyed through gamification.

When asked about the challenges students perceive in integrating gamification elements, they provided various responses, focusing mainly on technical and motivational aspects. Some participants also mentioned challenges such as ensuring a good balance between gamification and knowledge transfer, as well as using gamification in a way that the enjoyment does not distract from the actual learning objective. According to the participants, the biggest challenge could be the technical equipment required for use. In this regard, it would be necessary to clarify in advance what hardware would be needed to implement the gamification elements. Some participants expressed doubts about existing motivation. It emerged that a lack of interest could result in no motivation, or that despite playful elements, interest could wane due to the higher purpose of learning. Another challenge, noted by one participant, could be increasing the motivation of young people who are already flooded with information by the media.

In connection with the use of gamification elements, the question was posed as to which elements students would prefer in the role of trainers. Here, group work was less focused. Instead, the use of challenges for trainees was emphasized. Other elements mentioned included leaderboards, points systems and, above all, reward systems to be used by trainers. Cooperative games were also repeatedly highlighted as relevant elements. Furthermore, four participants stated that they would use storytelling in training to teach sustainability, which was mentioned as an answer for the first time overall.
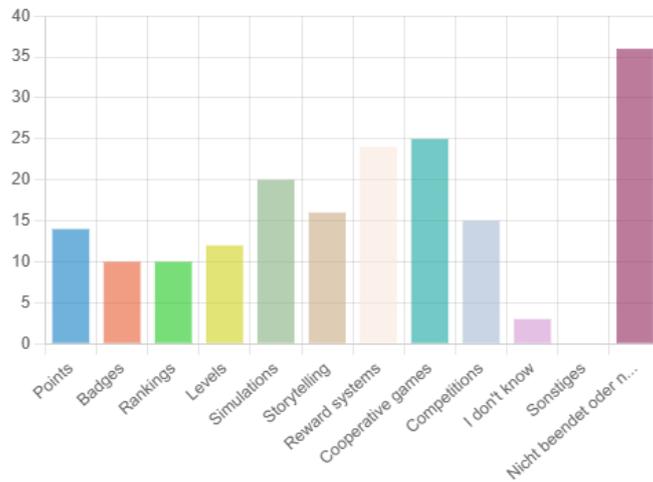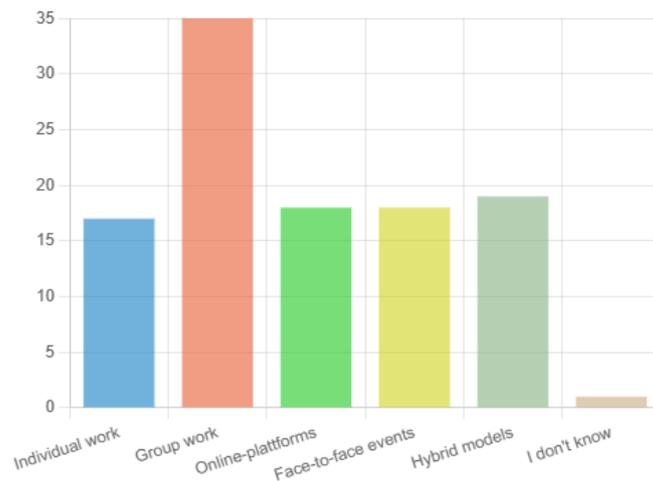
Figure 2: Most gamification elements innovative for sustainability topics

Figure 3: Preferred learning environment for the use of Gamification Elements

V. DISCUSSION

The survey received fewer respondents than originally anticipated. Nevertheless, an initial rough analysis of the overall situation regarding attitudes towards sustainability in vocational training institutions and its delivery is possible. The students were able to answer all questions without any time limits. During the survey, they had to put themselves in the position of a trainee and a trainer in order to answer the questions seriously.

It was already apparent at the beginning that most students possess a desired level of knowledge regarding the definitions of competence and sustainability. The reason for this may be their

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respective fields of study and the general awareness of these topics in society. It was found that a total of 23 people are not at all familiar with gamification, which suggests that they have less knowledge about the individual elements and their possible integration into vocational training institutions. For this reason, the term was defined after this section to compensate for this knowledge deficit.

Most of the questions utilized a Likert scale. For all questions using this scale, it was observed that more than half of the students selected responses between 'neutral' and 'very important'. The results also indicated that social interaction with one another was considered significant. This demonstrates that many students regard the use of gamification elements for sustainability as relevant, which at the same time points to a possible potential for integration into teaching.

Very few were familiar with digital games in relation to sustainability. This could be advantageous, as individuals do not associate specific apps with particular functions or design as a reference point. As a result, they might be more open to new and innovative approaches and variations for conveying content using gamification elements.

Group work was seen as the most positive learning environment for utilizing gamification elements to teach sustainability. This is further supported by the increased preference for the use of cooperative games, which could also help trainees strengthen their communication with one another, as well as tackle problem-solving tasks together.

The frequent selection of group work as a response suggests the possibility of learning topics more effectively and collaboratively in practice, and of

fostering both intrinsic and extrinsic motivation. There was increased approval for incorporating gamification elements in an interactive and playful manner, in order to bring the topic of sustainability closer to trainees. At the same time, this shows that part of the younger generation is consciously aware of the importance of teaching sustainability in vocational institutions and the growing significance it holds within companies.

Another point concerns the challenges involved in using playful elements. Before specific gamification elements can be utilized, it is essential to clarify which technical resources are available, which is why this challenge is certainly justified. However, thanks to the wide range of different elements, there should be sufficient options to address this challenge and tailor solutions to individual needs. Increasing trainees' motivation can also involve various further techniques, which can be combined with gamification elements. Nevertheless, it is important to ensure that the connection to real life and the seriousness of the subject are maintained, so that the gravity of the topic is not diminished.

Regarding gamification elements, a number of practical aspects were identified which can be well integrated into lessons. The reward system met with increased approval. However, it is important to focus on meaningfulness and good implementation. Many students emphasized that implementation is the decisive factor in this context. If rewards are given out too frequently, motivation can decrease, as they are no longer perceived as special. For this reason, it is important that the trainer possesses specific competences in teaching as well as the relevant knowledge about sustainability, so that these can be conveyed appropriately.

The students were also asked to put themselves in the role of the trainer for certain questions. In doing so, they only occasionally mentioned other gamification elements that did not match those they generally prefer for teaching sustainability. Storytelling and the suggestion to create their own gamification content were cited. The reward system was also frequently mentioned, which indirectly indicates that gamification elements can be well implemented and are compatible with actual effectiveness for individuals. For the analysis, it is important to focus on implementation here, as the manner of delivery can influence the development of intrinsic motivation among trainees.

VI. CONCLUSION

The survey revealed that an initial understanding of, and the importance attached to, sustainability is already partially present among the students. There are various approaches to introducing the topic of sustainability in an innovative way within vocational training institutions. The aim of this integration is to raise awareness among educational establishments and trainees of how urgent and relevant sustainable action is within companies.

However, the topic of sustainability is still not sufficiently represented in training institutions, making their proactive integration into lessons even more important. For this reason, a concept for communicating sustainability should be developed within the framework of the UN Sustainable Development Goals, shared with all training institutions and reviewed for accuracy at regular intervals.

The survey makes it clear that gamification elements are well suited to stimulating both intrinsic and extrinsic motivation, as well as to effectively imparting practical skills. Furthermore, it could foster social interaction. However, the requirements and competences to be acquired should be set out in writing and documented, so that a uniform structure and orientation are ensured regarding which competences are being referred to.

Science has already made significant progress in the fields of sustainability and gamification. However, this progress mainly relates to universities and higher education institutions, rather than to vocational training programs. The topic is scarcely addressed in academic literature, which is why scientific research in this particular area of education would be beneficial in order to gain insights into which sustainability competencies can be effectively conveyed. The present paper demonstrates, through its findings, that gamification elements such as reward systems and group work, as well as good and structured implementation, are promising approaches for introducing sustainability to trainees.

Future research could focus in more detail on specific disciplines within vocational training and examine the extent to which these characteristic differences influence the results of the present study. In addition, an analysis of socially disadvantaged trainees would be worthwhile, capturing and assessing the impact on the mentioned topic. Furthermore, a closer examination and investigation of various sustainability competences could provide a better overview of which competences are more conducive within specific areas of sustainability and which are less so. This could then be expanded and linked to gamification, thereby making it possible to develop a system—based on surveys and

test results—that identifies the most effective method of conveying specific sustainability competences.

As already mentioned in the discussion, not many participants found a suitable game for this particular topic. For this reason, another possible approach for the future would be to independently develop an app specifically targeted at trainees, which playfully conveys typical subject areas, for instance, through a reward system. However, it is crucial to invest increased effort in the implementation and development of the app to adapt and realize qualitative, quantitative and technical requirements for the target group accordingly.

Therefore, this approach involves a greater workload in terms of data collection of additional information and the analysis of the resulting data. Nevertheless, the app could prove to be worthwhile, since there are hardly any apps available focusing on this area. Furthermore, it would address a target group which, as previously mentioned, has scarcely been researched in relation to the communication of sustainability, and could therefore offer a good opportunity for data collection.

All in all, the paper demonstrates that gamification elements can be a valuable means of communicating sustainability topics, provided they are well adapted to the target group and implemented in a way that primarily increases the motivation of that group. Nevertheless, it remains of importance to further and more precisely research the aspects already mentioned, as well as additional ones within this field. Because of this, training institutions could benefit and gain advantages in the future, thus strengthening sustainability within their companies and among trainees.

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