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Research Article

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Gamification Reloaded

Current and Future Trends in Gamification Science

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Abstract: Gamification can help to increase motivation for various activities. As a fundamental concept in HCI, gamification has connections with various fields involving mixed reality, health care, or education. This article presents the expertise of 106 gamification specialists who participated in four workshops called "Gam-R — Gamification Reloaded." The extraction of current and future trends in gamification is the result of this. Four general topics, four in-depth topics, and seven emerging fields of application for gamification are depicted and enriched with the current state of research to support interested academic scholars and practitioners. Technical and less technical areas, which are the fields of work and research in gamification, are demonstrated. Some areas are already trending, while others are just beginning to show a future trend.

Keywords: Gamification, Motivation, Trends

1 Introduction

Gamification has developed into a well-known approach in human-computer interaction (HCI) and is here to stay. It represents a shift in organizations, systems, services, and activities to provide experiences, incentives, and capabilities similar to those found in good games [48]. The approach is being recognized and used in many research and application fields [43, 107]. From a scientific standpoint, gamification can aid in increasing motivation for education [5], taking part in a healthy lifestyle [2], adopting psychological elements for persuasive systems [62], and providing the groundwork for emerging fields such as esports [15].

This article covers current and future trends in gamification and insights gained from four workshops held at the Mensch und Computer conference series from 2018 to 2021. Researchers and practitioners can use the article's insights to gamify various areas, identify new objectives that gamification ideas address, and explore novel gamification approaches. In addition, this article proposes potential gamification research topics for future exploration.

The article is structured in three chapters. The first chapter briefly outlines what gamification is and distinguishes this area of research from other fields. In addition, the workshop series "Gam-R — Gamification Reloaded" is briefly presented, including the topics that were primarily discussed. This is followed by the second chapter, which serves as the key part, highlighting current and future trends in gamification science. The article finishes in the last chapter with a summarizing conclusion.

1.1 What Is Gamification and What It Is Not

Gamification is widely known as the use of game design elements in a nongame context [23]. An alternative definition of gamification is "the process of making activities more game-like" [133, p. 2]. Gamification is therefore based on bringing the motivating effect associated with games to nongame situations by employing game elements as an incentive system but without actually playing a game. However, individuals are often under the misconception that gamification is, in fact, a game [93, pp. 1379–1380]. Gamification is not a product by itself, and it is not created in the same way that a game is; gamification is closer to game design and not to games and in a particular case, can lead to gamified applications that are not even intended to be fun [66, p. 317].

By applying gamification, individuals are inspired to engage in an activity for a longer time or enhance their performance by doing specific tasks in this manner [116]. Gamification comprises several parts [134] and can include theoretical aspects such as goals, feedback, simplified user experience, and social comparison [63].

Defining gamification, however, is not as conclusive as presented thus far. Many approaches try to give an overview of gamification definitions, but most fail to provide significant support for the gamification community or researchers. For example, Schöbel et al. try to separate the

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definitions into four dimensions, ending with most definitions being in 2 or 3 dimensions at the same time while making it questionable if the "setting" dimension is indeed a dimension and whether this categorization is helpful at all [111, pp. 707–708]. At the same time, however, it must be acknowledged that this is an approach that has failed others as well, which is why the relatively simple definition by Deterding et al. about game design elements in a nongame context [23] is still relevant.

1.2 Gam-R — Gamification Reloaded Workshop Series

The international workshop series "Gam-R — Gamification Reloaded" was established after the Mensch und Computer conference 2017 in Regensburg, Germany. The workshop allows scholars and practitioners to present and discuss new and (yet to be completely matured) research ideas. Furthermore, applications and research regarding gamification that meet a good scientific standard are appreciated. The presented research can then be analyzed at the workshop by gamification researchers to gain input from the community, e. g., for future initiatives and research. Thus far, four workshops have been conducted:

- 1st International Gam-R — Gamification Reloaded workshop 2018 in Dresden, Germany, with 30 participants [79]. Four presentations were given, with a strong focus on industry.
- 2nd International Gam-R — Gamification Reloaded workshop 2019 in Hamburg, Germany, with 33 participants [80]. In 2019, the focus of the four presentations was learning in the broadest sense.
- 3rd International Gam-R — Gamification Reloaded workshop 2020 in Magdeburg, Germany (virtual) with 26 participants [81]. Supporting novice coders was the topic of two presentations, and an ignition talk on how to link AI and gamification was the cornerstone of the 2020 workshop.
- 4th International Gam-R — Gamification Reloaded workshop 2021 in Ingolstadt, Germany (virtual) with 17 participants [82]. An ignition talk on gamification in drug counseling for youth kicked off the workshop. This was followed by two presentations on the topics of smart homes and gamification in the workplace. The workshop concluded with a bar camp on gamification in the banking sector, audio gamification, quantified self, and gamification in MOOCs.

The workshop welcomes topics on different themes, such as the use of gamification in various contexts, gamification for different groups of users, e. g., for children or the elderly, and the analysis of individual game design elements. The full-day workshops offer the possibility of presenting accepted articles, networking with other researchers, and increasing the visibility of gamification in research and practice. Usually, the workshop is split into two parts: The first part consists of the presentation and in-depth discussion of accepted submissions, while the second part consists of a discussion on open (research) aspects, further research goals, and where a future joint approach takes place [79–82]. In this second part of each workshop, four topics were discussed in formal and informal settings:

- Missing aspects of gamification research — Where are we right now? (Section 1.3).
- Element's design of gamification (Section 1.4).
- Drawbacks and threats of gamification (Section 1.5).
- Benefits and opportunities of gamification (Section 1.6).

A brief summary of each of the four topics is presented in their respective sections (1.3–1.6). These four topics were the main topics around which the general discussion took place. This then gave rise to the four more detailed topics. The idea to cluster these four main topics emerged after the first workshop, where participants collected ideas individually with large presentation cards, and afterward, the group clustered the topics. At the second workshop, the topics were provided on four large posters, and rotating focus groups added ideas and remarks. The third and fourth workshops incorporated the findings from the first two workshops, and participants could provide additional input and remarks on virtual whiteboards, have the previous results displayed, or just give feedback verbally.

The topics discussed most are included in the second chapter, "Current and Future Trends in Gamification Science." Overlaps between the sections are intended to show the different interconnections within this multifaceted research topic.

1.3 Missing Aspects of Gamification Research — Where Are We Right Now?

For the participants, the most crucial aspect of each workshop was the so-called issue of "missing gamification." As a result, a vast mix of topics was discussed, including context, methods, implementation, and definitions of gamification. A brief overview of these four areas mentioned follows, whereby this has always been by far the workshop

discussion part with the most debate and includes to a large extent Section 2.1 (Focusing the Research Area).

Context, which is covered in Section 1.4, also seems to be a source of infinite discussions, which at the same time represents the importance of the perception of the workshop participants. Long-term effects (see Section 2.4) and target group-specific research are always among the first topics discussed. In this regard, despite (or perhaps because of) cultural and demographic differences, it is essential to consider these differences for successful gamification design to achieve improved accessibility [60]. Different gamification services have to be considered [42], and in addition to the usual gamified areas such as commerce or education [14], less frequent but also very important areas, such as occupational safety, are moving into the focus of gamification [18].

Methods of gamification science have been and still are a challenging field, leaving much to be desired. The classic method approach is to obtain self-reported data via storyboards [39], questionnaires, or surveys [61]. These are usually easier to conduct but provide fewer insights because these findings are less equivalent in terms of validity to well-executed inferential studies such as experiments [43]. Controlled studies are required to enhance gamification research and gain knowledge about the actual impacts of gamification, ideally over a longer period (see also Section 2.4).

The workshop participants frequently expressed a desire for a method toolbox, where they could simply reach in and find a gamification solution for any problem. While research has been conducted on various frameworks, e. g., Mora et al. analyze 18 different gamification frameworks [87], the panacea hoped for has, unsurprisingly, not yet been found.

Moving away from the points-badges-leaderboards triad (see also Section 2.3) and implementing less frequently used game design elements such as narrative while considering ethical issues (see also Section 2.5.7) are also often articulated aspects. However, simultaneously, the "quality" of gamification, or rather to achieve the desired goals with gamification, leads to a dissent in the game design elements to be used, as expressed by the workshop participants.

Last, there was always a debate at the workshops about various definitions of gamification, which is not new to gamification research [48, 66, 121]. Depending on the perspective and context, different definitions may well come into question. An in-depth analysis of this situation would go beyond this article's scope. It is not surprising, however, that gamification and games are often confused with each other because, in some cases, such comparative (scientific) research is carried out [69].

1.4 Element's Design of Gamification

The second point in the workshop participants' discussion was related to the design of the game design elements. The main focus of the discussions was on two aspects: complexity and context.

The workshop participants prefer a low barrier for using a gamified system, not only in general but also for individuals with disabilities [119]. In addition, gamification should be intuitive to understand and use. In particular, an emotional design should generate a feeling of immersion [136]. At the same time, the gamification design must also be created for mobile devices [138], and usability must be considered [40, 50, 95]. However, this has led to controversy in the discussions because usability tends to make systems self-explanatory, while gamification can also contain game design elements that may be surprising [138]. This is thus a challenge for traditional designers.

It is essential to consider the context of the intended use, such as whether something is public or even representative or "just" for self-motivation. The gamified system's goals and stakeholder objectives must be aligned while also keeping the organization's or experimental setting's constraints in mind [12, 32, 102]. Finckenhagen identifies 28 different contextual factors, such as age, gender, level of education, and personality [32], which can influence gamification. For example, if we wish to gamify online shopping vs. education, the contexts are fundamentally different. In the first case, an individual wants to boost website activity, but in the second situation, the emphasis is on maintaining a high level of learning attention [71].

These two topics, complexity, and context were overshadowed entirely by general discussions about game design elements. Further workshop discussions and ideas about individual, joint, and user-related effects of game design elements can be found in Section 2.2.

1.5 Drawbacks and Threats of Gamification

Various risks and disadvantages of gamification were considered at the four workshops. The most frequently raised issues were those concerning motivation, system implementation, legal and ethical considerations. Interestingly, motivational aspects have dominated the discussions. "Too much gamification" could lead to a tiring perception, and too much repetition can lead to a risk of habit so that

the desire for the task fades. Additionally, intrinsic motivation could perhaps disappear [45].

According to implementation aspects, the monetary costs to implement and design "good gamification" can be underestimated or worse, have a budget that is too small. This could lead to "bad gamification, e. g., "pointification" and a decrease in intrinsic motivation, which is also already being addressed in gamification science [103]. A disadvantage is that the external perception of gamification could be problematic, and that gamification may be associated with games rather than work, according to the workshop participants.

Legal and ethical issues were also introduced into the discussion. With social scoring in China as a prominent example [101], data protection due to data collection and monitoring, which functions as an incentive to cheat or trick the system, risk of abuse and social pressure due to competitive orientation, and even the risk of addiction, have all been identified as potential drawbacks of gamification. This topic is examined in more detail in Section 2.5.7.

1.6 Benefits and Opportunities of Gamification

Finally, the participants in the workshops discussed the benefits and opportunities of gamification. The most salient feature of gamification was the ability to stimulate (self-)motivation for boring and unpleasant activities. Additionally, gamification is perceived as a strategy for creating or promoting a flow state [41]. However, unlike flow theory, which needs complete attention to achieve flow [20], gamification combines game design elements in such a manner that they are experienced both consciously and unconsciously.

Another benefit is the opportunity to use gamification to create a connection between people, i. e., a sense of belonging. This fits very well with the assumptions of self-determination theory, a prominent theory in gamification science [84, p. 2], where social relatedness is a basic psychological need [21].

Interestingly, as already briefly discussed in Section 1.4, adaptive and tailored gamification, which fits the context and complexity of a given situation, is expected to be a critical opportunity in gamification research. However, the workshop participants were at the same time somewhat hesitant and did not believe in a swift and targeted implementation, despite the slow but steady publication of new scientific research about this aspect [10, 38, 59, 68]. The hesitation is mainly based on disagreement with existing models about various learning and player types [47, 109].

Fourth, the use of gamification with augmented reality (AR) and virtual reality (VR) was increasingly noted. This topic is examined in more detail in Section 2.5.3.

2 Current and Future Trends in Gamification Science

Not all future trends are meant to be found in the future. For example, ethical aspects of gamification are already under discussion but only as niche research. This chapter will provide a longer summary of the (additional) results of the four workshops with 106 participants from science and practice in the field of gamification. The first four sections will discuss issues about focusing on gamification research, the different effects of game design elements, chances for less frequently used game design elements, and in Section 2.4 thoughts about long-term effects and experiments in gamification science. This is followed by a section about seven emerging fields of application for gamification.

2.1 Focusing the Research Area

Many different definitions plague gamification and efforts have been made to align them over time [104]. Furthermore, even if it seems surprising, scientific engagement in the self-understanding of gamification is a contemporary and future trend in scientific research.

The dispute starts with whether we are dealing with game mechanics [16] or game design elements, which also consist of dynamics, mechanics, and components [134, p. 78]. The ambiguities continue with terms such as gamification, serious games, game-based learning, simulation games, business games, or even just games [50, 63, 134]. These terms are often used interchangeably, although they are different domains. For example, serious games have the primary purpose of educating rather than entertaining [65]. It is beyond the scope of this article to address each definition individually, so here only reference is made to the literature that has dealt with the differences extensively [50]. Along with this, further theory building is appropriate to advance the field and it will have implications for practice [63].

Finally, there is some dispute about the definition of gamification itself. The definition by Deterding et al. is probably the most frequently cited, according to which

gamification use game design elements in a nongame context [23]. Alternative definitions have emerged that on the one hand criticize the vagueness of the aforementioned definition and propose new definitions [48, 116, 134] but at the same time are themselves only valid for limited areas or remain vague, e. g., "the process of making activities more game-like" [133, p. 2]. Some authors even argue for the use of a nondefinition of gamification [121]. Further research will show whether such approaches are promising.

The workshop participants engaged much less in heated discussions about definitions. Instead, they acknowledged the differences between, e. g., serious games and gamification and focused more on practical issues and whether definitions can pose boundaries for specific gamification implementations. As a result, the discussion of gamification definitions was frequently deemed "academic," and a shift to other topics was encouraged.

2.2 Game Design Elements: Individual-, Joint- and User-Related Effects

The main feature of gamification revolves around the game design elements [23], which led to some vivid discussions among workshop participants, especially what can be considered a game design element. The number of existing game design elements varies in the literature. For example, Werbach et al. mention 30 game design elements divided between game dynamics, game mechanics, and game components [134]. Radoff identifies 42 elements that are fun to play and proposes them for usage in nongame contexts [100]. However, other authors have identified over 100 game design elements [129].

To complicate the issue even more, game design elements can be mapped according to different aspects. Blohm and Leimeister, for example, have done this based on motives [9]. Sailer et al., on the other hand, on the foundation of (basic) psychological needs [108].

Usually, points, badges, and leaderboards, also known as the PBL triad, are used [71, 134] and are also the most examined game design elements in gamification research [61]. Points are considered essential for any gamified system [138] and have different properties, such as experience points and skill points [107]. In addition, points can keep score, determine the current status, provide feedback, and can be seen as an external display of improvement [108], [134, pp. 72–73]. Badges are "digital artifacts that have some visual representation" [4, p. 1]. Antin and Churchill also argue that "the most obvious function of badges is as a goal-setting device" [4, p. 2]. Badges can be judged to be very effective for increasing user activity [40]. Recent studies, on the other hand, do not show such positive results or conclusions [64, 88]. Finally, leaderboards are used to compare individuals and are again a visual display of progression and achievement [134, p. 80]. Various forms are possible, such as a social ranking that (again) acts as a feedback mechanism [73, 74].

Research has shown that it is unclear whether and how to choose the use of individual game design elements in contrast to joining multiple game design elements. Usually, gamification research often combines different game design elements but does not explain these combinations, as in Morschheuser et al. [89]. This leaves unanswered the individual effect of game design elements [85]. Hamari et al. state that "[...] most of the quantitative studies concluded positive effects to exist only in part of the considered relationships between the gamification elements and studied outcomes." [43, p. 3029] and Hanus et al. conclude that "[...] the effectiveness of various gamification elements have not been sufficiently tested." [45, p. 152]. Finally, Cermak-Sassenrath summarizes many studies where the effects of individual game design elements are either not clear or are not desirable and even demotivating [14, pp. 123–125]. In a recent series of studies by Groening and Binnewies, they argue "that a high amount of game design elements benefits motivation and performance" [36, p. 1130]. However, at the same time, they need in an experiment three game design elements to outperform a control condition without any game design element in terms of motivation and performance [36]. This also supports the unclear situation regarding the effect of individual game design elements.

Possible effects of individual elements often remain undetected. However, this detection is required to support effective design decisions, which is also recognized as a research gap in gamification research [61]. In general, research that compares gamification versus no gamification without properly separating elements or relevant element clusters has minimal theoretical relevance and should be avoided [66, p. 330]. Nonetheless, there are currently relatively few experimental studies that reflect the effects of individual game design elements [12, 17, 49, 67, 74–76, 108].

However, using several game design elements at the same time does not always have to be designed to enhance or neutralize an existing effect. It is also possible to actively control the user's actions by making only one game design element responsible for them, even if others exist and are used alongside them. Kizina et al. provide experimental findings using a "booster" element to push other activities, in addition to the provision of other game design elements [58]. Overall, much research is still needed, particularly on the effects of individual game design elements

and especially how individual game design elements differ.

Finally, user-related effects need to be considered. The effects of game design elements tend to have different effects on different individuals [107]. A difference in the effect can often be explained by age and gender differences, with usually higher mean effects for males but with higher variances for females, including the higher proportion of those individuals who are particularly strongly motivated [12, 51, 60]. However, many different interactions between gender and personality appear to have an impact on perceived game design elements [22].

Debates at the workshops acknowledged insufficient empirical evidence about individual game design elements and that only points, badges, and leaderboards are usually considered. This issue is briefly investigated in the following section.

2.3 No Longer PBL — Other Game Design Elements and Their Challenges

Game design elements such as points, badges, leaderboards, and feedback are heavily researched game design elements [40, 85, 116, 138]. Despite the PBL triad's popularity and perceived success, it is well known that it can have a negative impact on motivation and performance in a variety of ways [84, 85], with leaderboards being a prime example [12, 46, 134]. In addition, Kapp states that the "most effective gamification efforts include more than points and badges – they contain elements of story, challenge and continual feedback [...]" [53, p. 52].

On the other hand, game design elements rarely considered in gamification research are, e. g., progress bars and narratives. They are therefore, considered a niche in gamification research compared to other game design elements [24, 34, 61, 122]. Additionally, having an avatar to support user activity is a gamification approach, but one that is also flawed, like other nontypical game design elements, by the time-consuming creation and the high amount of time an individual needs to dedicate in comparison to, e. g., points or a leaderboard [8].

Stories or narratives are used in many games, and gamification has a slow uptake of this game design element [35, 76, 108]. According to Keusch and Zhang, based on intensive literature analysis, it is critical for the impact of a narrative embedded into an application to be contextually appropriate [55]. Further studies show the potential of a narrative game design element [94] for gamification and that it can overcome the challenges of traditional game design elements [128].

Many discussions among the workshop participants about the PBL triad showed an ambivalent perception of these game design elements. On the one hand, it was accepted and there was the desire to get away from the PBL triad because of the negative experiences with leaderboards. On the other hand, the high cost of less frequently used game design elements and the uncertainties about success are real barriers to implementing other game design elements. Again, all participants agreed that more research is needed.

2.4 Long-Term Effects and Experiments

Scientific results are more valid the longer an experiment lasts. In particular, long-term experiments are considered favorable. However, "many studies of gamification measure only short-term effects while long-term effects remain unclear." [14, p. 125]. Of course, this is not a problem specific to the field of gamification, but here too, the demand for longer evaluation periods and, in contrast, the reality of too short evaluation periods and, in some cases, very small numbers of subjects are evident. There is a risk (and partly reality) that gamification's perceived joy and usefulness decrease over time [60]. In a recently published study by Silic et al., the result of a 1-year study reported that gamification can also be effective over a longer period and can even increase in its desired effect [117]. This gives hope for further long-term studies and results, which go in the same direction.

One classic experiment from Thom et al., shows the effects of removing gamification from an enterprise network [126]. However, while a minimal positive effect in favor of gamification could still be found in the long term in this experiment, this is not the case in other studies. For example, it was not possible to show the long-term impact of an app-based behavior change intervention on household electricity savings in Switzerland one year after the intervention was executed [132]. A recent analysis of articles about removing gamification provides insight in terms of mixed results and a lack of empirical studies [115].

Some experiments show long-term positive effects of gamification, e. g., one by Hamari [40]. What is missing, however, is a progression of activity over time, which is not reported. Other studies have found the same mixed interpretations [45]. Additionally, mixed interpretations can be drawn from studies that rely on long-term surveys and not experiments, despite the large samples they accumulated [130, 136]. Finally, Barata et al. use a 3-year study to separate users into six different player types. It is interesting to

note that the player types developed differently over time [6].

In general, empirical data, especially from experiments, are missing. Kasurinen and Knutas also highlight this issue by stating that "[...] it is plausible to argue that the most pressing issue of the research work in gamification is to collect evidence on the practical applications and their impact." [54, p. 43]. A summary of different analyses provides insight that thus far, 104 articles with empirical data have been identified and analyzed by several authors in meta-reviews [14, p. 123]. While 104 articles are a significant number, it is important to keep in mind that these empirical studies reflect a very long period in the field of gamification research, at least 10 years of practical application, or even 20 years of scientific gamification research [14, p. 125]. The challenge is that evidence-based gamification research with empirical data and preferably with experiments, which have clearly defined control groups and are based on theory-based hypotheses, has been very rare thus far. The existing preference for survey studies no longer meets the demand for reliable results. This is all the more urgent because many of the results are described as "mixed or inconclusive" [14, p. 123].

This issue was also always acknowledged by the workshop participants. A shift away from survey studies to experiments, including treatment and control groups, is desired by both researchers and practitioners.

2.5 Emerging Fields of Application for Gamification

Gamification is and has been used in many academic areas and fields of application. Cermak-Sassenrath summarizes these areas by including health, education, commerce, intraorganizational systems, sustainable consumption, work and workplace, innovation, data gathering, consulting, marketing, customer loyalty, online communities, and social networks, along with crowdsourcing [14]. It makes no sense to extract open research gaps and new fields of application for gamification from each of these fields. This is beyond the capacity of this article.

Instead, this article will focus on some areas that have been mentioned in detail at the "Gam-R — Gamification Reloaded" workshops and which could be of interest for pioneering projects in gamification: artificial intelligence and machine learning, science, augmented, virtual and mixed reality, Internet of Things, analog gamification, gamification for individuals with disabilities, and last, ethical aspects.

These seven areas have one thing in common: workshop participants rated them as a high priority. Therefore, brief summaries of these areas follow, without specifically mentioning the high prioritization from the workshop, except for gamification for individuals with disabilities in Section 2.5.6.

2.5.1 Artificial Intelligence and Machine Learning

Artificial intelligence (AI) and machine learning (ML) methods are gaining increasing importance in various fields, such as health [52], material science [37], education, and many more [137], even if numerous ethical questions remain unanswered or are still being explored [120]. Khakpour and Colomo-Palacios provide an impressive systematic literature review of 43 articles about gamification and machine learning [56]. The authors highlight that most applications of gamification and ML can be found in the field of learning analytics [56, p. 598]. Additionally, concepts for adaptive gamification with ML have been introduced [56, p. 599].

One issue, which is not limited to the use of gamification and AI/ML alone, however, is that "there is a very limited number of challenges reported by the researchers, as they are normally focusing on the strengths of their work in the reports." [56, p. 621]. This makes it challenging to conduct a realistic assessment of the potential of combining AI/ML with gamification. In particular, the missing randomization of the subjects for 31 of the 43 studies enables only a very limited interpretation of the findings [56, pp. 628–631].

A novel approach has been taken by Voit, Schneider, and Kriegbaum [129]. The authors do not use AI to derive relevant information for gamification and decision-making from user behavioral data that a live gamification system could use to influence behavior. Instead, they use AI to detect game design elements in game instructions of board games and to generate design suggestions to support the selection and combination of game design elements for nongame contexts [129]. For more than 30,000 board games, between 78 % and 90 % accuracy has been achieved, and more than 100 game design patterns have been documented [129, p. 3].

Nevertheless, at the moment, mixed results dominate, and movement away from the desired results is often attributed to external influences [27, p. 15]. To date, AI and ML have been the most promising trends in computer science, making significant advances in, e. g., health and medical science, but many pitfalls are scraping the hype and showing the challenges of reality [28].

2.5.2 Science

Science and gamification already have some shared history through citizen science [11, 29]. At the same time, gamification is a promising way to help researchers advance their careers, especially for collaboration and reproducible research [30, 31]. Indeed, gamification can provide incentives and benefits to researchers and enhance education and training/administration best practices in science [31].

In addition, gamification can help to engage with open science and open access [13, 77, 78]. Kidwell et al. showed that badges could motivate scientists to share data [57]. Many universities, research institutes, and funding organizations are increasingly promoting open access, including open access to scientific publications, although adoption has been gradual [97]. Gamification could act as a potential motivator and accelerator in these areas to facilitate adoption.

2.5.3 Augmented, Virtual and Mixed Reality

Augmented reality (AR), virtual reality (VR), and mixed reality (MR) are quickly advancing areas in computer science and already have ties with gamification, e. g., AR with gamification in museums [44], VR with gamification for medical education [123], or MR with gamification to learn music [86]. Of course, these are just a few areas, but examples of use can be found everywhere in the main application areas of gamification already mentioned, such as education and health.

Just as fragmented as the different application areas are, so is the state of implementation of gamification in the different realities. From concepts [114] to prototypes [92] and fully implemented experiments, in this case about order picking [12], a wide variety of research methods are applied in the field of AR, as also for VR and MR.

Embodiment with VR and gamification is a new trend to achieve a high level of immersive VR [118] and advances the field of brain-computer interfaces with AR/VR/XR [98]. Furthermore, the impact of COVID-19 is already being recognized and addressed in combination with AR/VR and gamification [7].

2.5.4 Internet of Things

The Internet of Things (IoT) enables linked devices to record, communicate, and gather data via a network using a variety of sensors, laying the groundwork for applications such as smart grids, smart automobiles, and smart cities [70]. Alla and Nafil provide an overview and show that this topic has gained strong movement in the gamification area since 2017, with primary settings in education, energy consumption, and sustainability [1].

Indeed, sustainability is a topic that is trending because of climate change. Douglas and Brauer show in a recent literature review how gamification is used to tackle energy reduction, education about sustainability, air quality, waste management, and water conservation [26], which are also topics closely related to the IoT. Gamification is also considered for innovation in the IoT and Industry 4.0 to advance sustainability [96]. To address these challenges, various IoT frameworks have been proposed [70, 95].

2.5.5 Analog Gamification

It may seem strange to deal with analog gamification because gamification is usually only considered a digital phenomenon. Nevertheless, analog gamification is trending in security scenarios such as social engineering, incident management, or data security and can be set up in an analog education situation [112, 113]. In some cases, an analog approach, instead of "classic" digital gamification, can provide a simple alternative with lower acceptance barriers. For example, Kizina [58] reported in the workshop that their digital approach to gamification had been analogized to ancillary activities in the office as a result of the study. A complex digital application was transformed into an analog board in the coffee room, where employees could use clothespins to set tasks and goals.

Recently, Mee et al. proposed a conceptual model of analog gamification to enhance motivation for learning, including aspects such as engagement and attitude [83]. However, the potential is also seen in the area of public health [99], and unusual areas such as urban gamification [124] and the COVID-19 pandemic [125].

2.5.6 Gamification for Individuals with Disabilities

Another issue that was raised by the participants was gamification for individuals with disabilities. We should honestly admit that this should actually not be a trend but a matter of course. Gamification research has also recognized this and is approaching the complex terrain with scientific studies. Smith and Abrams provide a very detailed article as they prioritize gamification, take into account

the requirements of learners, including those who identify as disabled, and highlight critical questions regarding equality and access to digital instructional resources [119].

Colpani and Homem propose a framework including AR and gamification to assist learning for individuals with intellectual disabilities, mainly children. Combining a framework and AR with gamification results in a prototype that could successfully address the issue [19]. A different approach is considered by Wong, who opts to foster the musical creativity of students with intellectual disabilities using gamification [135].

One approach the workshop participants discussed to support individuals with disabilities is a sort of audio gamification, meaning, e. g., using gamification on audio-only devices without any screen. Thus far, there is a (somewhat premature) concept of educational audio gamification and no pure audio gamification, but this is a step in the right direction for the participants [105, 106]. A starting point to approach audio gamification could be audio games, which, unlike classic video games, do not focus on visual elements [33]. However, as in classic gamification, it is possible to extract game design elements from audio games and to use them in other contexts.

2.5.7 Ethical Aspects of Gamification

Ethical aspects of gamification are receiving increasing attention in the scientific community, e. g., some authors argue that addiction to game-like elements such as gamification can occur [3]. Andrade et al. also mention additional problematic activities, such as off-task behavior or undesired competition [3, pp. 178–179]. This is closely related to misguided game design elements, e. g., a risk of using a narrative is that the storyline can become a distraction from the real-world situation [90, p. 8]. At the same time, providing reward-based gamification is something to try to avoid with regard to creating long-term change in the subject's behavior [90, p. 3].

Leaderboards appear to be the most problematic game design element here. The reason for this is that leaderboards may have an overly competitive effect. This would be toxic for the individuals who negatively react to this game design element. According to the current state of research, this often seems to be the case [3, 12, 134]. Indeed, such negative results can be found for other game design elements, but it is particularly striking for leaderboards.

Additionally, when considering ethical aspects, gamification going (totally) wrong is of importance, e. g., if individuals actually invest more time in satisfying the gamification goal instead of the actual goal they want to fulfill [25]. Again, an entire article could be filled with this topic. So besides possible addiction, aspects such as gamification being perceived as shamification or exploitationware [72], manipulation or unwanted competition by applying gamification [91], utilizing stealthy persuasion or stealth marketing [127], or gamification facilitating the radicalization of individuals [110] are some of the facets to take into consideration with regard to ethical characteristics in gamification.

These ethical aspects were mentioned or discussed during the four workshops but without arriving at definitive proposals for solutions. Despite the importance of the other trends mentioned in this article, this may have the most pressing issue.

3 Conclusion

Gamification is becoming a fundamental concept in HCI with an extensive professional and interdisciplinary orientation. This article describes the findings of four yearly and consecutive workshops titled "Gam-R — Gamification Reloaded" and the expertise of 106 specialists taking part in these workshops. These findings were supplemented with state-of-the-art scientific literature to support their validity and the need for further research.

Considerable research is still required on aspects such as context, methods, and implementation of gamification, especially with experiments and target group-specific research to analyze long-term effects. For game design elements, complexity and context are still two substantial research gaps. Adaptive and tailored gamification could be helpful to deal with context but might also add complexity in terms of implementation. This article presents numerous examples of (mostly) successful gamification and promising trends in this area. However, gamification is not a no-brainer, and many risk factors can lead to the failure of ambitious gamification projects [131, p. 1309].

Indeed, a stronger focus on the state of research could improve the overall situation in gamification research. Individual game design elements and their interactions still contribute to many open research questions, including moving away from the PBL triad.

However, more specific areas of application for gamification were discussed at the workshops and in this article. While the use of gamification in the current trend around AI and ML will not come as much of a surprise, the dedicated application in the field of science is somewhat surprising. In addition, AR, VR, and MR are currently and in

the future, areas where gamification can show its full potential. This can also be considered in combination with the IoT, although standalone application areas have already been outlined in this context. Analog gamification, gamification for individuals with disabilities, and ethical aspects of gamification conclude the seven current and future trends for gamification. These however, as rather non-technical areas, have a much more significant influence on the four (more or less) technical areas than it might appear at first glance.

Many topics in gamification have been left out in this article, e. g., Landers et al. deal in more detail about various theoretical foundations [66]. However, the use, advantages, and disadvantages of various classifications of user types, including the issue that user types seem to be unstable [47, 109], are only briefly mentioned in this article. In addition, the contribution to various theoretical foundations or the discussion about intrinsic and extrinsic motivation of gamification was raised at the workshops but not truly discussed as they were other, more pressing gamification trends to discuss. Nevertheless, these are also important topics and are therefore mentioned here. However, in the mixture of participants in the workshops from science and practice, these topics played a subordinate role. Other participants might have a different focus. An article about current and future trends can therefore only represent a snapshot and can never be complete.

Academic scholars and practitioners can use this article to determine current and future trends in gamification. Through extensive discussions with 106 specialists in four workshops, a basis was created that indicates a direction of movement for gamification research. Even though most of the topics could only be briefly touched on in the article because of the large number of topics covered, this shows, even more, the dynamics and open challenges that still exist in gamification science. To make a difference in the gamification community, this is now the time to tackle these gamification trends.

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