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EFFECTIVENESS OF GAMIFICATION IN EDUCATION

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Gamification – using game elements to foster motivation

Motivation has long been identified as an essential factor in education. Among the aspects investigated in recent research on motivation in education are interest and intrinsic motivation (Wigfield et al., 2019). One way to reframe intrinsic motivation is to describe it as "fun" (Mitchell et al., 2020). While fun is difficult to define scientifically (Bisson & Luckner, 1996), the term is closely linked to games (Prensky, 2001). More precisely, certain characteristics of games can engage users by providing them with positive experiences (Prensky, 2001). This engagement can manifest as a mental state of intense concentration called "flow", during which players can achieve appreciable performance and pleasure (Csikszentmihalyi, 1992).

The video game industry in particular has displayed astonishing growth over the last 50 years. As such, the potential for video games to positively influence motivation and behavior has been of increasing interest in empirical research. Studies have shown that different aspects of video games affect users' motivation differently (Ryan et al., 2006). Accordingly, individual game elements have been used for decades as motivational affordances to enhance products and services (Hamari et al., 2014). While various terms have been used to describe this or similar processes (e.g., playfulness, gamefulness, gameful design, playful interaction design), "gamification" has been the most pervasive in recent empirical research. Deterding et al. (2011) define it as "the use of game design elements in non-game contexts" (p. 2), marking a keystone understanding of the concept. Gamification has since been deployed in various fields and disciplines such as business (Rocha et al., 2019) and tourism (Xu et al., 2017) or to promote well-being (Tolks et al., 2019).

However, the most common theme in recent gamification studies has been education (Kasurinen & Knutas, 2018). A list of commonly used game elements in education is provided in Section "Game elements used in education". Subsequently, a common theoretical framework of gamification application and research in education will be outlined (Section "Theoretical framework used in gamification (research)"). In order to reach conclusions about the effectiveness of gamification in education, the findings of several meta-analyses will be discussed in Section "Effects and moderating factors of gamification in education" before closing this chapter with practical implications.

Game elements used in education

Domain-specific taxonomies of game elements have been established (e.g., Bedwell et al., 2012 for education). However, only some of these elements have been implemented in educational settings. The nomenclature may vary, with terms like "game characteristic" (Prensky, 2001), "game design element" (Deterding et al., 2011) and "game attribute" (Bedwell et al., 2012). Following Landers (2015, see Section "Theory of gamified learning"), we will hereinafter use the term "game element". Below, we provide a collection of game elements that have been commonly used in education and examined in empirical research. This list is not meant to be exhaustive. We will also show how these elements might interlink in practice.

- **Points**
  Points are perhaps the simplest form of gamification. They constitute a basic form of immediate feedback to the user. Points might serve as a reward for completing tasks and illustrate progress in the learning process that might otherwise be difficult to grasp (Werbach & Hunter, 2012). As an extension of *point* systems, progress bars offer graphical information on learners' performance in relation to their previous accomplishments (Sailer et al., 2014). They can supplement *level-ups* by displaying certain thresholds of points or specific *quests* needed in order to advance. Reaching a certain number of points might award learners a *badge*. They can also act as a measure of social competition if the other learners' number of points is visible (*leaderboards*).
- **Leaderboards and rankings**
  Leaderboards and rankings allow the direct comparisons of learners' progress, representing a form of *competition*. This can be measured with *points*. There are absolute and relative types of leaderboards. The former type displays all users and their scores, while the latter only shows an individual user's score in relation to those directly above or below them (Ortiz-Rojas et al., 2019). Furthermore, leaderboards can be designed as public or anonymous. With public leaderboards, a higher position may lead to

increased motivation, while for anonymous ones, a higher position tends to be connected to better cognitive learning outcomes (Bai et al., 2021).

- **Badges and achievements**
  Badges and achievements are (semi-)permanent measures of progress that commemorate passing a specific task or reaching a certain goal. Awards such as these are thought to resemble classic goal-setting (Groening & Binnewies, 2019); that is, they don't necessarily act as rewards on their own. Instead, they point learners in the correct direction, with the fun and interest of goal-seeking being central to these game elements. They are likely more effective when they are designed to occur in low quantities and are more difficult to obtain (Groening & Binnewies, 2019).
- **(Timed) Quests, missions, and tasks**
  Quests, missions, and tasks are ways of reframing learning activities, which facilitate more personal experiences (Kim et al., 2018). Furthermore, a time limit might be placed on such activities, or additional content might be locked behind such tasks. Learners might also have to *collaborate* in order to complete a quest ("communal discovery"; Kim et al., 2018). Quests could also be framed diegetically (i.e., "in-universe") via *storytelling*. Successful and/or particularly quick completion of such a task might earn the learner a *badge*.
- **Avatars**
  Avatars are a virtual representation of an individual learner (Kim et al., 2018). They can be premade characters or "copies" of the users (Kapp, 2012). They can serve as distinguishing features for learners and facilitate their swapping into another role (Werbach & Hunter, 2012). Avatars might be customizable in order to enhance their abilities or the learner's sense of identification with that avatar (Kim et al., 2018).
- **Storytelling**
  The framing and context of the narrative can inject meaning into otherwise mundane scenarios and keep users engaged. It is especially useful when a real-world situation is perceived as boring and/or the narrative elements match personal interests. However, findings from the field of game-based learning suggest that the depth and complexity of narrative elements should be kept low (Clark et al., 2016).
- **Level-ups**
  A level-up can be achieved by reaching certain thresholds of *points* or accomplishing certain *quests, missions, or tasks*. The ability to gain a level usually denotes an increase in power or skill. This can be viewed as an alternative to personal progression in the form of *badges*, instead providing a linear continuum that users can ascend. Adding powers or increasing attributes, as in computer games, isn't seamlessly transitioned into education. Nevertheless, level-ups need to provide some form of perceived benefit to be effective (Bai et al., 2020).

- **Competition and collaboration**
  Competition and collaboration can be seen as forms of interpersonal or social interaction (Bedwell et al., 2012). Competition means learners compete for *points, badges*, or *level*-ups, while collaboration occurs when peers work together to achieve a shared objective (Ho et al., 2021). Both forms of interaction may be combined when teams compete against each other. Teammates can promote conflict, competition, or cooperation (Kapp, 2012). Team-based learning can foster motivation and increased performance, with smaller groups being generally more effective (Swanson et al., 2017). A common level of knowledge is key to any competitive or collaborative task, especially for teams, and such tasks should be started simultaneously (Landers & Landers, 2015).

There has long been criticism leveled at the "pointlessness" of points and badges (Werbach & Hunter 2012, p. 70). Research has shown the ubiquity of PBLs in gamified education (Bai et al., 2020). This might be due to their simplicity and ease of implementation and is often called "pointification" (Subhash & Cudney, 2018). This is also exacerbated by the fact that PBLs are often constituent parts of more complex game elements. For example, in order to facilitate a leveling system, *points* are usually needed to show a current value that students must reach in order to gain a *level-up*. Applications such as online quiz tools often come "pre-loaded" with these mechanics, as well. For instance, Kahoot! incorporates *points*, *leaderboards*, and *timed challenges* in its design, among others. However, recent research has found varying effects of leaderboards, depending on their design and the learners' performance, for example (Bai et al., 2021). Altogether, evidence suggests a) the development and implementation of new game elements (Zainuddin et al., 2020) and b) moving the focus of future investigations to more substantial, less researched forms of gamification in education in order to advance the field. To that end, a solid theoretical foundation and evidence-based teaching practices are of paramount importance.

Theoretical framework used in gamification (research)

In a meta-review, Krath et al. (2021) identified 118 different theories used for empirical research on gamification and game-based learning. A collection of the most prevalent can be found in Table 10.1. While game-based learning also encompasses the use of full-fledged games, gamification draws on some of their elements instead, as previously mentioned. Their findings illustrate the variety of theories applied in gamification research and the pervasiveness of gamification across various domains.

There is currently no common or agreed-upon integrated theory of gamification. By the numbers, self-determination theory serves as the most

TABLE 10.1 Prevalent theories in research of gamification, serious games, and game-based learning by type of learning outcome

Affective and motivational outcomes	*Behavioral outcomes*	*Cognitive outcomes*
• Self-determination theory	• Technology acceptance model	• Experiential learning theory
• Flow theory	• Theory of planned behavior	• Constructivist learning theory
• ARCS model	• Reinforcement theory	• Cognitive load theory
• Goal-setting theory	• Transtheoretical model of behavior change	• Social cognitive theory
• Self-efficacy theory	• Theory of reasoned action	• Situated learning theory
• Social comparison theory	• Activity theory	• Sociocultural theory of cognitive development
• Achievement goal theory		• Social learning theory
		• Multimedia learning theory

Note: This table shows the most-used theories in research of gamification, serious games, and game-based learning relating to affective and motivational, behavioral, and cognitive learning outcomes. Excerpt reprinted with permission from "Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning" by J. Krath, L. Schürmann, and H. F. O. von Korflesch, 2021, *Computers in Human Behavior, 125*, Article 106963.

important foundation of gamification research, being the most commonly used regarding affect and motivation (Krath et al., 2021). After elaborating on this key theory, we will highlight the two processes through which gamification can influence learning outcomes, according to Landers' theory of gamified learning (2015).

Self-determination theory

The connection between games and their potential to facilitate intrinsic motivation has long been made (Malone, 1981). Applying motivational elements to learning activities can affect the learning process positively (Cordova & Lepper, 1996). Since then, several studies have established a relationship between game elements and self-determination theory (Ryan & Deci, 2000; Mekler et al., 2017; Zainuddin et al., 2020). Three psychological needs that influence human behavior are defined by this theory: The need for autonomy, the need for competence, and the need for social relatedness (Ryan & Deci, 2000). For instance, teaching methods that support learners' autonomy can lead to increased effort applied to the learning process and can sustain

TABLE 10.2 Basic psychological needs according to self-determination theory and supporting game elements

Psychological need	*Supporting game elements*
Competence	• Points • Badges/achievements • Leaderboards/rankings • (Timed) Quests, missions, tasks • Level-ups
Autonomy	• Badges/achievements • (Timed) Quests, missions, tasks • Avatars • Storytelling
Social relatedness	• Badges/achievements • Leaderboards • Storytelling • Competition/collaboration

Note: This table shows three basic psychological needs that are matched with various gamification elements that can foster them. Adapted with permission from "Gamification als didaktisches Mittel in der Hochschulbildung" by D. Tolks and M. Sailer, 2021, *Digitalisierung in Studium und Lehre gemeinsam gestalten*, p. 517.

attention on the part of students (Baker & Goodboy, 2019). Self-determination is described as an active process. With this in mind, gamification can result in positive effects on learning (Ryan & Deci, 2000). Table 10.2 matches the game elements discussed in Section "Game elements used in education" with the basic psychological needs they can support (Sailer et al., 2017; Zainuddin et al., 2020).

As outlined, self-determination theory explains how learners' attitudes and behaviors might be positively influenced through the use of game elements. To further delineate how learning outcomes can be affected through gamification, the theory of gamified learning is showcased in the following section.

Theory of gamified learning

Drawing on the game element taxonomy of Bedwell et al. (2012), Landers (2015) introduced four components that describe the relationship between gamification and learning: (1) game elements, (2) instructional content, (3) behavior/attitude, and (4) learning outcomes. See Figure 10.1 for the processes in which gamification can affect learning outcomes.

By influencing behaviors and attitudes that, in turn, affect learning outcomes, gamification can improve existing instruction through a mediating

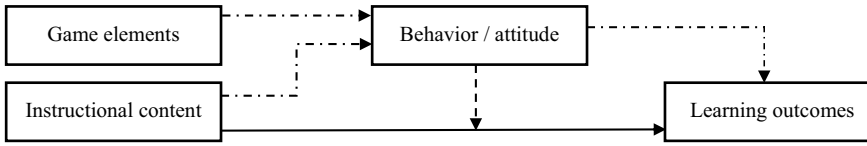

FIGURE 10.1 Theory of gamified learning.

Note: This figure shows the relationships between instructional content, learning outcomes, behavior/attitude, and game elements according to the theory of gamified learning. Directional arrows indicate theorized paths of causality. Dash–dot lines denote mediating processes. The dash line denotes a moderating process. The solid line denotes a direct influence. Adapted with permission from "Developing a theory of gamified learning: Linking serious games and gamification of learning" by R. N. Landers, 2015, *Simulation & Gaming*, *45*(6), p. 760.

process. This process has been supported empirically (Landers & Landers, 2015; Sailer & Sailer, 2020). Concurrently, behaviors and attitudes work as a moderating variable on the effect of instructional content on learning outcomes (Landers, 2015). This model illustrates that, in order for gamification in education to be effective, it cannot be separated from the instructional content. This is because learning outcomes are directly and causally influenced by effective learning materials and teaching tools. As a result, gamification cannot replace instruction. Instead, its goal is to further enhance instruction that is already effective by itself (Landers, 2015). This further means that, in order to evaluate gamified learning, research designs that deliberately target interactions between the variables described in Landers' model are needed.

To identify the beneficial behaviors that gamification can support, we draw on Chi and Wylie's (2014) taxonomy of learning activities. In the ICAP framework, they differentiate four modes of engagement: Interactive, constructive, active, and passive. Higher levels of student engagement are assumed to relate to higher levels of cognitive activity (Chi et al., 2018). It should be noted that, in practice, the design of constructive and interactive learning activities can be difficult (Ha et al., 2020). However, the motivating potential of game elements (Ryan et al., 2006) can be used to facilitate these higher modes of engagement. For example, interactive group discussions might be framed through storytelling and/or as timed, competitive missions. Meanwhile, the reward for the successful completion of the mission in the form of badges can be tied to especially fruitful collaboration. No matter the implementation, the instructional content should be relevant to the desired learning outcomes for this framework to be most effective (Chi & Wylie, 2014). This is in line with Landers' (2015) theory, as shown above. While the ICAP framework takes a probabilistic approach, in that higher levels of activity are *more likely* to lead to improved cognitive activity (Chi & Wylie, 2014), it illustrates how gamification can foster active learning (Prince, 2004).

Effects and moderating factors of gamification in education

The application and research of gamification have spanned widely across domains, with extensive theoretical approaches (see Section "Theoretical framework used in gamification (research)") and a defragmented knowledge base (Schmidt-Kraepelin et al., 2018). Still, the most pressing research issue currently is to collect evidence on the practical applications of gamification (Kasurinen & Knutas, 2018). Despite an overall maturation of gamification research (Nacke & Deterding, 2017), many questions remain. In order to shed light on the overall effects of gamification in education, we will discuss the results of four select, recent meta-analyses that also demonstrated moderating effects on gamification and learning (see Table 10.3). All of them showed significant, small to medium positive overall effects of gamification

TABLE 10.3 Selection of meta-analyses on the effects of gamification on learning, their focused learning outcome(s), and reported effect sizes of gamification on said learning outcomes

Meta-analysis	*Focus*	*Effect(s) of gamification on learning outcomes*
• Sailer and Homner (2020)	• Cognitive learning outcomes • Affective/motivational learning outcomes • Behavioral learning outcomes	• g = 0.49, 95% CI [.30, .69], k = 19, N = 1686 (cognitive outcomes) • g = 0.36, 95% CI [.18, .54], k = 16, N = 2246 (motivational outcomes) • g = 0.25, 95% CI [.04, .46], k = 9, N = 951 (behavioral outcomes)
• Bai et al. (2020)	• Cognitive learning outcomes • Learners' attitudes	• g = 0.504, 95% CI [.284–.723], N = 3202 (cognitive outcomes) • Attitudes were measured qualitatively
• Huang et al. (2020) • Ritzhaupt et al. (2021)	• Cognitive learning outcomes • Affective/motivational learning outcomes • Behavioral learning outcomes	• g = 0.464, 95% CI [.244, .684], N = 3083 • g = 0.574, 95% CI [.384, .764], N = 1974 (affective/motivational outcomes) • g = 0.740, 95% CI [.465, 1.014], N = 1596 (behavioral outcomes)

Note: This table names four recent meta-analyses on the effects of gamification on learning. Their respective focus on affective/motivational, behavioral, and/or cognitive learning outcomes is identified. Overall effect sizes of gamification on learning outcomes reported in each meta-analysis are provided.

or game elements on learning outcomes. This range of effect sizes aligns with the findings from other meta-analyses on the subject that either found no moderating effects or focused on only a few specific game elements (Yildirim & Şen, 2019; Vermeir et al., 2020; Kim & Castelli, 2021).

Sailer and Homner (2020) performed one of the first comprehensive meta-analyses on gamification and learning, differentiating between cognitive, affective/motivational, and behavioral learning outcomes. Bai et al. (2020) supplemented their investigation of gamification and cognitive learning outcomes with a synthesis of data from 32 qualitative studies. In contrast to the previous works, the related meta-analyses of Huang et al. (2020) and Ritzhaupt et al. (2021) focused on individual game elements and their effects on cognitive, affective/motivational, and behavioral learning outcomes, respectively. The selected works found contextual, situational, and methodological moderators that will be illustrated in the following section and are shown in Table 10.4. Afterwards, the analyses' results will be discussed.

TABLE 10.4 Moderating factors of gamification on learning

Meta-analysis	*Significant moderating factors found (excerpt)*
Sailer and Homner (2020)	• Inclusion of game fiction (in favor of presence for behavioral learning outcomes) • Social interaction (in favor of presence for behavioral learning outcomes) • Period of time (motivational learning outcomes) • Research context (cognitive learning outcomes) • Randomization (motivational learning outcomes)
Bai et al. (2020)	• Period of time
Huang et al. (2020)	• Leaderboards (in favor of absence) • Collaboration (in favor of presence) • Competition (in favor of absence) • Quests/missions/modules (in favor of presence) • Type of publication
Ritzhaupt et al. (2021)	• Competition (in favor of presence for effective learning outcomes) • Non-linear navigation (in favor of presence for behavioral learning outcomes) • Adaptivity/personalization (in favor of absence for behavioral learning outcomes) • Narrative/storytelling (in favor of absence for behavioral learning outcomes) • Publication bias

Note: This table lists all factors found by four recent analyses that significantly moderated the effect of gamification on affective/motivational, behavioral, and/or cognitive learning outcomes. Where applicable, it is mentioned whether the absence or presence of certain game elements was reported as more beneficial for learning outcomes.

Game elements and learning outcomes

Table 10.4 shows a list of the game characteristics that led to significant differences when present or absent. The following section will first elaborate on the results for cognitive, affective/motivational, and behavioral learning outcomes.

- **Leaderboards**
  For cognitive learning outcomes, Huang et al. (2020) found that the absence of leaderboards led to higher statistically significant effect sizes when compared to their presence.
- **Storytelling**
  The inclusion of game fiction was reported as bearing a significant, small positive effect on behavioral learning outcomes in contrast to a nonsignificant result of not including game fiction by Sailer and Homner (2020). In contrast, Ritzhaupt et al. (2021) found the absence of narrative/storytelling to be significantly more effective than its presence.
- **Quests, missions, and tasks**
  For cognitive learning outcomes, Huang et al. (2020) found that quests yielded the largest noted effect size for a game element.
- **Competition and collaboration**
  In Huang et al.'s (2020) sample, competition was employed more often than collaboration (21 vs. nine studies). Interestingly, studies that did not use competition reported higher statistically significant effect sizes on cognitive learning outcomes than those that did. Meanwhile, the use of collaboration led to the second highest reported effect size in this meta-analysis. Sailer and Homner (2020) coded social interaction as "none", "competitive", "collaborative", and "competitive-collaborative". For cognitive and affective/motivational learning outcomes, no significant differences were found. However, results showed that a combination of competition and collaboration was significantly more effective than no social interaction for behavioral learning outcomes. Ritzhaupt et al. (2021) did not find significant differences concerning the presence or absence of competition or collaboration for behavioral learning outcomes. However, the presence of competition led to the highest statistically significant effect size compared to its absence.
- **Non-linear navigation**
  Learners might follow a single, linear path toward an ultimate learning goal. When they are, instead, presented with multiple possible paths, Ritzhaupt et al. (2021) refer to it as non-linear navigation. They found that behavioral learning outcomes were positively and significantly influenced if non-linear navigation was not used.

- **Adaptivity and personalization**
  Adaptivity and personalization intend to provide learners with tailored options in gamified learning environments. For example, teacher scaffolding might be adjusted based on the learners' performance. Ritzhaupt et al. (2021) found the presence of this game element to be significantly detrimental to behavioral learning outcomes when compared to its absence. However, only a small number of studies investigated adaptivity and personalization, which impedes the capability of making design suggestions based on this finding.

Contextual, situational, and methodological moderators

- **Period of time**
  Gamification interventions can last for varying amounts of time, with different numbers of play/learning sessions. Sailer and Homner (2020) found that gamified learning instances lasting half a year or less were significantly more effective toward affective/emotional outcomes than those lasting one day or less. Contrasting these findings, Bai et al. (2020) noted that shorter gamified interventions had greater average effect sizes in their research.
- **Research context**
  For cognitive learning outcomes only, Sailer and Homner (2020) found that the effects in school settings were significantly higher than those in higher education or informal education settings. This might be explained by control groups in schools receiving traditional passive instruction, while those in higher education might have received mixed instruction.
- **Randomization**
  Quasi-experimental and experimental study designs differed significantly in Sailer and Homner's (2020) meta-analysis for affective/motivational and behavioral learning outcomes. This might hint at methodological rigor as a possible moderator of the effect size.
- **Type of publication**
  For Huang et al.'s (2020) sample, dissertations and theses reported overall negative effect sizes. In this way, they differed significantly from journal articles and conference proceedings that reported comparable positive effect sizes.
- **Publication bias**
  One outlier for both affective/motivational and behavioral learning outcomes resulted in a threat to the respective models in Ritzhaupt et al.'s (2021) analysis.

While some of the delineated results align, others do not. It is of note that the sampled studies varied between the meta-analyses, which might explain

varying effect sizes. A second-order analysis would be helpful to more accurately and uniformly present a picture of gamification in education.

One point of conflict is the interaction of gamification and period of time. Is it better to have longer-lasting gamified interventions or shorter ones? One indication is provided by a longitudinal study (Rodrigues et al., 2022). Gamification has been reported to suffer from the novelty effect, meaning its perceived benefit decreases with time (Koivisto & Hamari, 2014). However, it may also benefit from the familiarization effect, according to Rodrigues et al., forming a U-curve. This means that after an initial downtrend, the declining effect of gamification is counteracted by learners becoming more familiar with the game elements and other aspects of the intervention. This process might take from two to six weeks. More longitudinal studies on the effects of gamified interventions are needed to further assess the long-term effects of gamified interventions.

Another point of contention relates to the effects of competition and collaboration. For example, the discussed findings show differences in cognitive vs. behavioral outcomes. Another meta-analysis on gamification and the impact of peer competition and collaboration found a moderating effect of competition on cognitive learning outcomes, but not of collaboration (Ho et al., 2021). This further adds to the inconsistency of the findings on this topic and points to the need for closer examinations. Bai et al. (2020) offered a possible explanation: In their qualitative synthesis, students reported feelings of jealousy or anxiety as one drawback of gamification. The latter might especially arise during competitive tasks. To this end, Rigby and Ryan (2011) distinguished between competition that is either constructive or destructive. The latter occurs when winning is perceived as more important than improving the skills of everyone involved. As a result, destructive competition can stifle feelings of social relatedness.

An aspect not touched upon by most analyses is that of difficulty. When learners perceive a task as too easy or too hard, their engagement may decrease (Baten et al., 2019). For example, gamified tasks or quizzes that are too difficult can lead to a decrease in feelings of competence (Sailer & Sailer, 2020). However, evidence suggests that by providing a task-related choice before learning, the negative effects of high-perceived task difficulty could be reduced (Schneider et al., 2022). Another way of handling difficulty is through the anchoring effect, in which learners who complete easier tasks at the start perceive subsequent, more difficult tasks as possible (Kim et al., 2018).

Building on the critique of pointification (see Section "Game elements used in education"), there mostly were no significant differences in the presence or absence of PBLs in gamified interventions. As a result, the authors unanimously argue for exploring and combining other game elements in education.

While differences in the effects of gamification are suspected between subject areas, there is not enough representation in all observed domains to gauge this interaction appropriately.

It is also of note that the coding of game elements varied between the meta-analyses. While some authors recorded the presence or absence of various game elements (e.g., Huang et al., 2020; Ritzhaupt et al., 2021), Sailer and Homner (2020) differentiated them further. Consequently, future research should be less about "either-or", and more about "how": For example, if storytelling elements are present, how relevant and deep are they to the learning experience (Clark et al., 2016)? These distinctions might help with more finely assessing the effects of game elements in education.

Most gamification implementations are adaptive systems and thus provide different feedback to different learners. This might result in different effects of game elements on different learners (e.g., Bai et al., 2021). Further, the interactions of individual differences (e.g., learners' prior knowledge or motives) with single game elements might influence the effects of gamification on different learners, as well. However, these differentiated effects and interactions have hardly been investigated in gamification research, as yet.

Evidence-based practice recommendations

- There is consistent evidence that the use of game elements (gamification) in education is an effective way of fostering cognitive, affective/motivational, and behavioral learning outcomes.
- According to Landers' (2015) theory of gamified learning, game elements influence attitudes and behavior that, in turn, affect the learning outcomes (mediating process). Additionally, attitudes and behavior act as moderators on the direct effect of instructional content on learning outcomes. This means that gamifying learning processes cannot remedy low-quality teaching methods, instead further enhancing well-designed instruction that can promote active learning.
- Gamification research uses a wide range of theoretical frameworks, with a focus on motivational aspects. Specific game elements have been shown to foster the psychological needs for autonomy, competence, and social relatedness. They should thus be used accordingly and combined to target all three of these needs.
- The use of points, badges, and leaderboards is so ubiquitous that there seem to be no significant differences, whether present or absent. As such, new game elements should be developed and implemented into gamified learning (Zainuddin et al., 2020) while providing elaborate feedback in the form of teacher scaffolding (Clark et al., 2016).

References

Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review*, *30*, 100322. https://doi.org/10.1016/j.edurev.2020.100322

Bai, S., Hew, K. F., Sailer, M., & Jia, C. (2021). From top to bottom: How positions on different types of leaderboard may affect fully online student learning performance, intrinsic motivation, and course engagement. *Computers & Education*, *173*, 104297. https://doi.org/10.1016/j.compedu.2021.104297

Baker, J. P., & Goodboy, A. K. (2019). The choice is yours: The effects of autonomy-supportive instruction on students' learning and communication. *Communication Education*, *68*(1), 80–102. https://doi.org/10.1080/03634523.2018.1536793

Baten, E., Vansteenkiste, M., De Muynck, G.-J., De Poortere, E., & Desoete, A. (2019). How can the blow of math difficulty on elementaryschool children's motivational, cognitive, and affective experiences bedampened? The critical role of autonomy-supportive instructions. *Journal of Educational Psychology*, *112*(18), 1490–1505. https://doi.org/10.1037/edu0000444

Bedwell, W. L., Pavlas, D., Heyne, K., Lazzara, E. H., & Salas, E. (2012). Toward a taxonomy linking game attributes to learning: An empirical study. *Simulation & Gaming*, *43*(6), 729–760. https://doi.org/10.1177/1046878112439444

Bisson, C., & Luckner, J. (1996). Fun in learning: The pedagogical role of fun in adventure education. *Journal of Experiential Education*, *19*(2), 108–112. https://doi.org/10.1177/105382599601900208

Chi, M.T. H., Adams, J., Bogusch, E. B., Bruchok, C., Kang, S., Lancaster, M., Levy, R., Li, N., McEldoon, K. L., Stump, G. S., Wylie, R., Xu, D., & Yaghmourian, D. L. (2018). Translating the ICAP theory of cognitive engagement into practice. *Cognitive Science*, *42*(6), 1777–1832. https://doi.org/10.1111/cogs.12626

Chi, M. T. H., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educational Psychologist*, *59*(4), 219–243. https://doi.org/10.1080/00461520.2014.965823

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Research*, *86*(1), 79–122. https://doi.org/10.3102/0034654315582065

Cordova, D. I., & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology*, *88*(4), 715–730. https://doi.org/10.1037/0022-0663.88.4.715

Csikszentmihalyi, M. (1992). The flow experience and human psychology. In M. Csikszentmihalyi & I. S. Csikszentmihalyi (Eds.), *Optimal experience: Psychological studies of flow in consciousness* (pp. 16–35). Cambridge University Press.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9–15). Tampere: ACM.

Groening, C., & Binnewies, C. (2019). "Achievement unlocked!"–The impact of digital achievements as a gamification element on motivation and performance. *Computers in Human Behavior*, *97*, 151–166. https://doi.org/10.1016/j.chb.2019.02.026

Ha, J., Su, M., Chi, M. T. H., & Cullicott, C. (2020). Misunderstandings of Teachers Applying ICAP Theory into Practice. In M. Gresalfi, & I. S. Horn (Eds.), *The Interdisciplinarity of the Learning Sciences, 14th International Conference of the Learning Sciences (ICLS) 2020, Volume 4* (pp. 2407–2408). Nashville, Tennessee: International Society of the Learning Sciences.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? A literature review of empirical studies on gamification. In R. H. Sprague Jr. (Ed.), *Proceedings of the 47th Annual Hawaii International Conference on System Sciences* (pp. 3025–3034). Washington, DC: IEEE. https://doi.org/10.1109/hicss.2014.377

Ho, J. C.-S., Hung, Y.-S., & Kwan, L. Y.-Y. (2021). The impact of peer competition and collaboration on gamified learning performance in educational settings: A meta-analytical study. *Education and Information Technologies*, *27*, 3833–3866. https://doi.org/10.1007/s10639-021-10770-2

Huang, R., Ritzhaupt, A. D., Sommer, M., Zhu, J., Stephen, A., Valle, N., Hampton, J., & Li, J. (2020). The impact of gamification in educational settings on student learning outcomes: A meta-analysis. *Education Technology Research and Development*, *68*, 1875–1901. https://doi.org/10.1007/s11423-020-09807-z

Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. John Wiley & Sons.

Kasurinen, J., & Knutas, A. (2018). Publication trends in gamification: A systematic mapping study. *Computer Science Review*, *27*, 33–44. https://doi.org/10.1016/j.cosrev.2017.10.003

Kim, J., & Castelli, D. M. (2021). Effects of gamification on behavioral change in education: A meta-analysis. *International Jourrnal of Environmental Research and Public Health*, *18*(7), Article 3550. https://doi.org/10.3390/ijerph18073550

Kim, S., Song, K., Lockee, B., & Burton, J. (2018). *Gamification in learning and education. Enjoy learning like gaming*. Springer. https://doi.org/10.1007/978-3-319-47283-6

Koivisto, J., & Hamari, J. (2014). Demographic differences in perceived benefits from gamification. *Computers in Human Behavior*, *35*, 179–188. https://doi.org/10.1016/j.chb.2014.03.007

Krath, J., Schürmann, L., & von Korflesch, H. F. O. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. *Computers in Human Behavior*, *125*, Article 106963. https://doi.org/10.1016/j.chb.2021.106963

Landers, R. N. (2015). Developing a theory of gamified learning: Linking serious games and gamification of learning. *Simulation & Gaming*, *45*(6), 752–768. https://doi.org/10.1177/1046878114563660

Landers, R. N., & Landers, A. K. (2015). An empirical test of the theory of gamified learning: The effect of leaderboards on time-on-task and academic performance. *Simulation & Gaming*, *45*(6), 769–785. https://doi.org/10.1177/1046878114563662

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, *5*(4), 333–369. https://doi.org/10.1207/s15516709cog0504_2

Mekler, E. D., Brühlmann, F., Tuch, A. N., & Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. *Computers in Human Behavior*, *71*, 525–534. https://doi.org/10.1016/j.chb.2015.08.048

Mitchell, R., Schuster, L., & Jin, H. S. (2020). Gamification and the impact of extrinsic motivation on needs satisfaction: Making work fun? *Journal of Business Research*, *106*, 323–330. https://doi.org/10.1016/j.jbusres.2018.11.022

Nacke, L. E., & Deterding, S. (2017). Editorial: The maturing of gamification research. *Computers in Human Behavior*, *71*, 450–454. https://doi.org/10.1016/j.chb.2016.11.062

Ortiz-Rojas, M., Chiluiza, K., & Valcke, M. (2019). Gamification through leaderboards: An empirical study in engineering education. *Computer Applications in Engineering Education*, *27*, 777–788. https://doi.org/10.1002/cae.12116

Prensky, M. (2001). Fun, play and games: What makes games engaging. In M. Prensky (Ed.), *Digital game-based learning* (pp. 05-1–05-31). McGraw-Hill.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, *93*, 223–231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Rigby, S., & Ryan, R. M. (2011). *Glued to games: How video games draw us in and hold us spellbound*. Praeger.

Ritzhaupt, A. D., Huang, R., Sommer, M., Zhu, J., Stephen, A., Valle, N., Hampton, J., & Li, J. (2021). A meta-analysis on the influence of gamification in formal educational settings on affective and behavioral outcomes. *Education Technology Research and Development 69*, 2493–2522. https://doi.org/10.1007/s11423-021-10036-1

Rocha, E. M., Pereira, G. M., & Pacheco, D. A. D. J. (2019). The role of the predictive gamification to increase the sales performance: A novel business approach. *Journal of Business & Industrial Marketing*, *35*(5), 817–833. https://doi.org/10.1108/JBIM-01-2019-0005

Rodrigues, L., Pereira, F.D., Toda, A.M., Palomino, P. T., Pessoa, M., Carvalho, L. S. G., Fernandes, D., Oliveira, E. H. T., Cristea, A. I., & Isotani, S. (2022). Gamification suffers from the novelty effect but benefits from the familiarization effect: Findings from a longitudinal study. *International Journal of Educational Technology in Higher Education*, *19*(13). https://doi.org/10.1186/s41239-021-00314-6

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, *30*(4), 344–360. https://doi.org/10.1007/s11031-006-9051-8

Sailer, M., Hense, J., Mandl, J., & Klevers, M. (2014). Psychological perspectives on motivation through gamification. *Interaction Design and Architecture Journal*, *19*, 28–37.

Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior*, *69*(Supplement C), 371–380. https://doi.org/10.1016/j.chb.2016.12.033

Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, *32*(1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Sailer, M., & Sailer, M. (2020). Gamification of in-class activities in flipped classroom lectures. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.12948

Schmidt-Kraepelin, M., Thiebes, A., Baumsteiger, S., & Sunyaev, D. (2018). State of play: A citation network analysis of healthcare gamification studies. In *Research Papers, 173* (p. 1–17). *European Conference on Information Systems (ECIS2018)*, Portsmouth. https://aisel.aisnet.org/ecis2018_rp/17

Schneider, S., Nebel, S. Meyer, S., & Rey, G. D. (2022). The interdependency of perceived task difficulty and the choice effect when learning with multimedia materials. *Journal of Educational Psychology*, *114*(3), 443–461. https://doi.org/10.1037/edu0000686

Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. *Computers in Human Behavior*, *87*, 109–206. https://doi.org/10.1016/j.chb.2018.05.028

Swanson, E., McCulley, L. V., Osman, D. J., Scammacca Lewis, N., & Solis, M. (2017). The effect of team-based learning on content knowledge: A meta-analysis. *Active Learning in Higher Education*, *20*(1), 39–50. https://doi.org/10.1177/1469787417731201

Tolks, D., & Sailer, M. (2021). Gamification als didaktisches Mittel in der Hochschulbildung. In *Digitalisierung in Studium und Lehre gemeinsam gestalten* (pp. 515–532). Hochschulforum Digitalisierung. https://doi.org/10.1007/978-3-658-32849-8_29

Tolks, D., Sailer, M., Dadaczynski, K., Lampert, C., Huberty, J., Paulus, P., & Horstmann, D. (2019). ONYA – the wellbeing game: How to use gamification to promote wellbeing. *Information*, *10*(2):58. https://doi.org/10.3390/info10020058

Vermeir, J. F., White, M. J., Johnson, D., Crombez, G., & van Ryckeghem, D. M. L. (2020). The effects of gamification on computerized cognitive training: Systematic review and meta-analysis. *JMIR Serious Games*, *8*(3), Article e18644. https://doi.org/10.2196/18644

Werbach, K., & Hunter, D. (2012). *For the win: How game thinking can revolutionize your business*. Wharton Digital Press.

Wigfield, A., Faust, L. T., Cambria, J., & Eccles, J. S. (2019). Motivation in education. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (pp. 443–461). Oxford University Press.

Xu, F., Buhalis, D., & Weber, J. (2017). Serious games and the gamification of tourism. *Tourism Management*, *60*, 244–256. https://doi.org/10.1016/j.tourman.2016.11.020

Yildirim, I., & Şen, S. (2019). The effects of gamification on students' academic achievement: A meta-analysis study. *Interactive Learning Environments*, *29*(8), 1301–1318. https://doi.org/10.1080/10494820.2019.1636089

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review*, *30*, Article 100326. https://doi.org/10.1016/j.edurev.2020.100326