Journal of Theoretical Educational Science, 17(4), 873-896, October 2024
Kuramsal Eğitimbilim Dergisi, 17(4), 873-896, Ekim 2024
[Online]: http://dergipark.org.tr/akukeg
DOI number: http://doi.org/10.30831/akukeg.1478810

A Review on Personalization of Gamified Learning Environments*

Oyunlaştırılmış Öğrenme Ortamlarının Kişiselleştirilmesi Üzerine Bir Derleme

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Received: 5 May 2024 **Review Article** **Accepted:** 27 August 2024

ABSTRACT: This study explores the personalization of gamification in educational contexts, particularly adaptive approaches to meet diverse learner needs. The study examines terminologies and offer definitions for adaptive, tailored, personalized, and customized gamification. Personalization serves as an umbrella term covering any changes in the process. Customization is the changes performed by the user/learner; tailored gamification involves adjustments made at the beginning and adaptive gamification involves system-driven changes as things progress. The analysis of adaptive gamification studies is structured around adaptation criteria, adaptation process, adaptation data, and adaptive intervention. Adaptation criteria include player types, personality models, learning styles, and hybrid profiles. Adaptation process includes user-controlled and system-controlled adaptation. User-controlled adaptation refers to customization; system-controlled adaptation is examined under static adaptation, dynamic adaptation, and combination of these two. Adaptation data is categorized under explicit and implicit information collection. Lastly, recommendations, and adjusting game elements and mechanics are discussed under adaptation intervention. The review highlights the commonly used player typologies, including Bartle, Hexad, and BrainHex, and personality models such as Big Five and Myers-Briggs Type Indicator. The review identifies limitations in current frameworks, stressing the importance of standardized models and guidelines to implement adaptive gamification and incorporating gamification analytics to sustain adaptation and automation.

Keywords: Adaptive gamification, tailored gamification, customization, personalization.

ÖZ: Bu çalışma kişiselleştirilmiş oyunlaştırmanın eğitsel bağlamlardaki kullanımını, özellikle de oyunlaştırmanın farklı öğrenen ihtiyaçlarına yönelik uyarlanmasındaki yaklaşımlar açısından incelemektedir. Çalışma bu bağlamda kullanılan uyarlanmış, uyarlanabilir, kişiselleştirilmiş ve özelleştirilmiş oyunlaştırma terimlerini inceleyerek bu terimlere ilişkin tanımlar ortaya koymuştur. Kişiselleştirilmiş oyunlaştırma, oyunlaştırma sürecindeki herhangi bir değişikliği tanımlayan şemsiye kavramdır. Uyarlanmış oyunlaştırma, uygulamanın başlangıcında yapılan değişikliklerdir. Uyarlanabilir oyunlaştırma, sistem tarafından uygulama sırasında dinamik olarak yapılan değişikliklerdir. Özelleştirme, oyunlaştırma sürecinde kullanıcı/öğrenci tarafından yapılan değişiklikleri ifade eder. Uyarlanmış oyunlaştırma çalışmaları dört başlıkta incelenmiştir: uyarlama kriterleri, uyarlama süreci, uyarlama verisi ve uyarlama müdahalesi. Uyarlama kriterleri, oyuncu tipleri, kişilik modelleri, öğrenme stilleri ve karma profilleri içermektedir. Uyarlama süreci, kullanıcı-kontrollü ve sistem-kontrollü uyarlamayı içerir. Kullanıcı-kontrollü uyarlama, özelleştirmeyi ifade etmekte, sistem-kontrollü uyarlama ise statik uyarlama, dinamik uyarlama ve bu ikisinin kombinasyonu olan dinamik+statik uyarlama altında incelenmektedir. Uyarlama verileri, açık ve dolaylı bilgi toplama yöntemleri olarak iki kategoriye ayrılmaktadır. Son olarak, öneriler ve oyun bileşen ve mekaniklerinin uyarlanması, uyarlama müdahalesi altında ele alınmıştır. Çalışma, Bartle, Hexad ve BrainHex gibi oyuncu tiplerinin ve Beş Faktör ve Myers-Briggs gibi kişilik modellerinin uyarlama çalışmalarında sıklıkla kullanıldığını göstermektedir. Çalışma ayrıca mevcut çerçevelerdeki sınırlılıkları, oyunlaştırmanın nasıl uyarlanacağını gösteren standartlaştırılmış modellerin önemini ve uyarlamanın otomatikleştirilmesi ve sürdürülebilir olması için oyunlaştırma analitiğinin entegrasyonunu vurgulamaktadır.

Anahtar kelimeler: Uyarlanabilir oyunlaştırma, uyarlanmış oyunlaştırma, özelleştirme, kişiselleştirme.

* This study is part of the PhD thesis of the first author under the supervision of the second author.

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Citation Information
Ertan Şevk, K., & Arkün Kocadere, S. (2024). A review on personalization of gamified learning environments. *Kuramsal Eğitimbilim Dergisi [Journal of Theoretical Educational Science], 17*(4), 873-896.

ISSN: 1308-1659

Gamification has been becoming a widely common trend in recent years. Simply put, it can be defined as using game elements in non-game environments (Deterding et al., 2011). It can also be explained as the act of turning a non-game environment, an application, or a process into a game through some game-specific mechanics or principles and making people feel like they are playing a game. Most of the applications or systems in our daily lives are gamified. Although the notion of turning something into a game has been prevalent over the long-term in domains such as marketing, "gamification" has emerged as a term in the 2010s (Nacke & Deterding, 2017). In the educational context, Kocadere and Çağlar (2018) defined gamification as an approach that involves incorporating game design elements to facilitate learners' participation, motivation and curiosity.

Game design elements have been structured differently by different researchers. The most well-known frameworks are the MDA framework (mechanics-dynamics-aesthetics) by Hunicke et al. (2004), Zichermann and Cunningham (2011); and dynamics - mechanics - elements by Werbach and Hunter (2012). These structures are often represented in a pyramid shape, in an order of abstraction. So, dynamics and aesthetics are the most abstract of these components. According to Hunicke et al. (2004) (p.2) aesthetics refers to the "desirable emotional responses" evoked in the player during interaction with the game system. Mechanics are the rules and rewards aiming to evoke certain emotions in learners; elements are the items that serve the mechanics and can be observed in the gamification design (Simões et al., 2013; Werbach & Hunter, 2012). Although many studies commonly use the aforementioned tripartite structures in many studies, some researchers (Bicen & Kocakoyun, 2018; Iosup & Epema, 2014; Karayiğit et al., 2022; Kocadere & Çağlar, 2018) prefer bipartite structures. In fact, Karayiğit et al. (2022), mentioned that there are no strict lines between the three categories and some components can act as an element or a mechanic depending on the context. To illustrate, a trophy in a gamification design can be considered as a reward component; however, in cases where there is no direct reward and the badges earned by the player are considered as rewards, the reward can be thought of as a mechanic (Karayiğit et al., 2022). Furthermore, the terminologies to define these elements may differ as well (Klock et al., 2020). Frequently employed elements and mechanics in gamification designs include point, badge, level, achievements, trophies, rankings, progress bar, virtual goods, leaderboard, gift, quest, team, avatar as elements; reward, progression, competition, narrative, altruism, feedback, challenge and status as mechanics (Antonaci et al., 2019; Zainuddin et al., 2020).

Based on the definitions, gamification aims to improve students' experience in terms of motivation, engagement, and academic performance by integrating game design elements into learning environments. Multiple studies have shown that gamification has positive effects on these aspects (Bai et al., 2021; Çağlar Özhan & Arkün Kocadere, 2020; Gironella, 2023; Zainuddin et al., 2020). Findings suggest that it enhances students' motivation by giving them instant feedback (Boverman et al., 2018), allowing them to keep track of their progress (Boverman et al., 2018; Li & Chu, 2021), rewarding for their actions (Domínguez et al., 2013), and increasing collaboration (Knutas et al., 2016; Li et al., 2013) or fostering a competitive atmosphere (Bai et al., 2021; Pilkington, 2018). By improving students' engagement and motivation, it affects students' achievement in a positive way (Çağlar Özhan & Arkün Kocadere, 2020;

Çakıroğlu et al., 2017; Pechenkina et al., 2017; Su & Cheng, 2015; Yu et al., 2023). However, the impact of gamification is not always positive; several studies have reported adverse outcomes or no outcomes at all. Elements that yield positive effects in certain cases may exhibit no effect or even result in negative outcomes in others (Hanus & Fox, 2015; Kwon & Özpolat, 2021; Kyewski & Krämer, 2018). One of the underlying reasons could be the fact that individuals are influenced by the diverse game design elements or mechanics (Hassan et al., 2021; Kocadere & Çağlar, 2018; Orji et al., 2018). In a systematic review by Ertan and Arkün Kocadere (2022), the significance of individual differences has emerged as a crucial finding of the study. As proposed by different studies, it is significant to design learning environments to accommodate diverse student needs and abilities and captivate their attention (Çağlar Özhan & Arkün Kocadere, 2020; Hassan et al., 2021). Considering individual differences of students results in effective and permanent learning (Şimşek, 2002), and also increased motivation and success (Erdoğdu, 2020). Hassan et al. (2021) argue that instead of offering the same experience to each student, gamification design should be tailored according to different learners. Their study reveals the positive effects of tailored gamification on students.

Based on the idea that traditional online learning environments often present similar content and structures to all students, which may lead to information density for users, adaptive learning systems have gained prominence (Eryılmaz & Şimşek, 2014). In this context, it can be seen that gamification studies have been trending in a similar direction in recent years with a notable emphasis on adaptive gamification. Adaptive gamification is based on the notion that different individuals' having different expectations, interests and personalities (Oliveira & Bittencourt, 2019) make difference in the way they react to game mechanics (Monterrat et al., 2015; Santos et al., 2021). Kocadere and Çağlar (2018) studied the preferences of learners with different player types and they included different game elements suited to all player types in their design to meet different expectations of learners. Monterrat et al. (2015) stated considering all player types within a single design would create an excessive load on the interface; therefore, they emphasized the need for a personalized gamification. In order to increase the efficiency of gamified systems, several models were developed that considered player types, personality traits, and motivation profiles (Tondello et al., 2016).

In regard to the idea that gamified environments should consider different learning styles, player profiles, individual differences and employ a "one size does not fit all" approach (Monterrat et al., 2015), concepts such as tailored gamification, adaptive gamification, personalized gamification and customized gamification emerged in the literature. These concepts share a common underlying principle, reflecting a change of strategy to suit individual needs or preferences (Klock et al., 2020).

In terms of tailored and adaptive gamification, researchers often use the terms "tailoring" and "adapting" interchangeably. The general idea of tailoring or adapting a gamified environment involves designing gamification by considering learner needs, preferences, and characteristics (Oliveira & Bittencourt, 2019). While the concepts of tailoring and adapting do not have strict boundaries between them, tailoring typically starts with creating a profile and builds adaptations from there (Klock et al., 2020; Kreuter et al., 2000). Adaptations can happen in real-time, in other words, a dynamic adaptation, or it can be a static adaptation (Hallifax et al., 2020). In a static system, the

adaptation happens just once, typically before learners begin using the learning platform. On the other hand, in a dynamic system, modification occurs multiple times while learners are engaging in their learning activities (Hallifax et al., 2019a). From this point of view, it can be said that while tailored gamification is associated with static adaptation, adaptive gamification aligns with dynamic adaptation. In the literature, there are also some studies that involve combined use of dynamic and static adaptation (Hallifax et al., 2021; Monterrat et al., 2015).

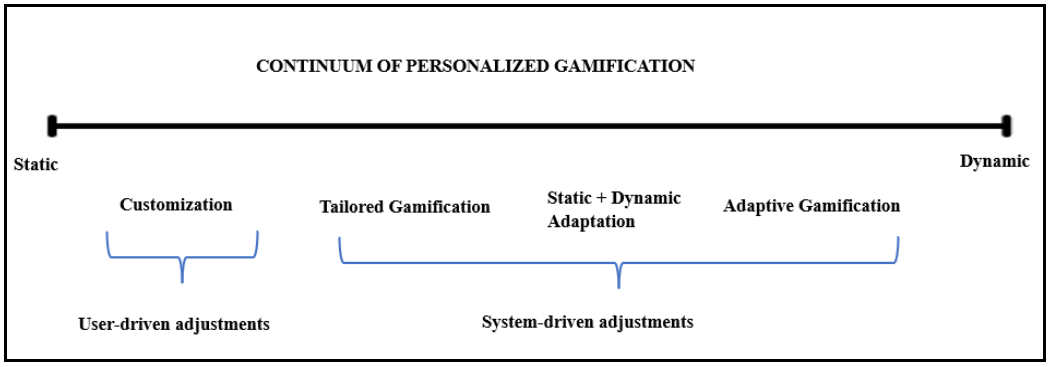
According to Oliveira and Bittencourt (2019), personalization refers to minor adjustments in the system such as changing the color of the game design elements based on the country or the time that the system is being used; on the other hand, tailored gamification implies modifications that go deeper and reach a higher level of complexity. These modifications are made on the basis of individual differences including learner typologies, player types, age and/or gender. Regarding customization, users have the opportunity to make changes in the system interface. For instance, the act of selecting an avatar for self-representation exemplifies this customized touch (Oliveira & Bittencourt, 2019). Sundar and Marathe (2010) explain the difference between customization and personalization, stating that personalization involves system-tailored adjustments while customization involves user-tailored adjustments. In this study, the definitions we provided are as follows:

- Personalized gamification serves as an umbrella term describing any changes in the gamification process.
- Customized gamification refers to the changes made by the user/learner during the gamification process.
- Tailored gamification includes changes made at the beginning of the process, based on data about the learners.
- Adaptive gamification includes dynamic changes made by the system throughout the process, based on data about the learners.

In Figure 1, the connection between these different terms in this context was visualized by the authors based on their own findings and interpretations derived from the literature.

Figure 1

Continuum of Personalized Gamification



Although the distinction between the terms used in adaptation context is less evident within the field of gamification, it becomes more pronounced when it comes to adaptive systems. Researchers (Brusilovsky et al., 1995; Oppermann, 1994) state that adaptive systems are the ones that employ collected information about the user to dynamically adjust their behavior, aiming to provide personalized experiences and content. There is also a distinction between adaptive and adaptable systems. Adaptable systems refer to the systems offering a degree of flexibility enabling users to customize certain features of the system according to their preferences or needs (Brusilovsky et al., 1995; Oppermann, 1994). Typically, computer-based teaching systems that enable users to select specific settings and modify the system's behavior are commonly known as learner-controlled instruction or adaptable systems. In contrast, adaptive systems, also known as program-controlled (system-controlled) instruction, automatically tailor their behaviors based on the user's needs (Lee & Park, 2008).

This study aims to explore and analyze different methods of adapting gamified learning environments, including the mechanisms and criteria used in adaptive gamification. In addition to explaining various terms in this context, it seeks to shed light on how tailored, adaptive, personalized, and customized gamification strategies are designed, implemented, and influence learning outcomes in educational settings. There is currently no consensus on these terms, leading to confusion in both research and practical applications. By defining these terms clearly, our study aims to provide a solid foundation for understanding and advancing adaptive gamification. Adaptive gamification offers promising opportunities to enhance engagement, motivation, and learning outcomes by catering to individual learner needs. This research addresses a gap in understanding by examining diverse approaches to adaptive gamification and their practical effects in educational contexts. By providing insights into effective design and implementation strategies, the study aims to contribute to optimization of gamified learning environments.

Method

This study adopts a literature review methodology to offer a comprehensive and insightful overview of the concept of adaptive gamification. Literature reviews or in other words review articles offer many possibilities to contribute to theory, progress our understanding of principles about a specific topic (Post et al., 2020) and provide a summary of current information, enabling the recognition of particular research theories, methodologies, and identifying gaps in the literature (Bennani et al., 2022). Given that strict inclusion/exclusion criteria limit the scope and may lead to relevant studies being overlooked, a systematic approach was deliberately avoided in this review. This allowed for a broad exploration of the topic using a variety of sources, which is very important in an emerging field such as adaptive gamification.

Adapting Gamified Learning Environments

Adapting educational experiences to individual needs and preferences within gamified settings has emerged as a critical domain aiming to increase motivation and enhance overall educational outcomes. However, a complete framework that defines the principles behind adaptive gamification solutions is missing and such a framework is crucial to outline the objectives of adaptive gamification elements (Böckle et al., 2018).

In terms of adaptive methods in educational hypermedia, the framework by Specht and Burgos (2007) was structured according to four main questions: (1) "What components of the educational system are adapted?" (2) "To what features of the user and the current context does the system adapt?" (3) "Why does the system adapt?" (4) "How does the system get the necessary information?" (p. 1). Böckle et al. (2018) proposed a design framework, inspired by Specht and Burgos's (2007) questions, which consists of four categories: "(1) Purpose of Adaptivity, (2) Adaptivity Criteria, (3) The Adaptive Game Mechanics & Dynamics, and (4) Adaptive Interventions" (pp. 1229–1230). Although two of the categories partly match (adaptivity criteria matches with *to what features of the user and the current context does the system adapt* and *purpose of adaptivity* matches with *why does the system adapt*), Böckle et al. (2018) extends it to address the specific aspects related to gamification. The details are as follows (Böckle et al., 2018):

- Purpose of adaptivity includes several reasons for adaptation such as changing the state of the user, which refers to modifying the end-user's attitude towards their goals, motivation, and beliefs, aligning them with the advantages of utilizing the system, supporting learners in the learning process, supporting active participation, and establishing a meaningful connection between the non-game context and the objectives of the end-users.
- Adaptivity criteria refers to the basis that the adaptation process builds on. It includes player type/personality type, usage/user-data, context, level of knowledge, defined goals by the user and reputation/status (p.1230).
- Adaptive game mechanics and dynamic include feedback, level difficulty, points and competition/customized challenges (p. 1230).
- Adaptive intervention is about gamification elements that show the outcomes of the adaptation process within the user interface. The most common intervention is giving suggestions and recommendations to let users know about their learning progress, like reminding them of upcoming deadlines or giving personal feedback. Adaptive intervention also includes a customized learning experience by adjusting the learning path to the user's existing skills or accomplishments, or by offering multiple paths to the same goal.

Codish and Ravid (2014) suggest a framework that includes gamification analytics to monitor how individuals perceive playfulness and engagement in specific contexts, which aims to establish usage patterns and adjust system rules accordingly. Similarly, the emphasis on using analytics to personalize feedback in gamified learning environments was exemplified in the study by Bayrak et al. (2021). Böckle et al. (2018) state that the user information sub element under adaptivity criteria in their framework was informed by the Codish and Ravid's (2014) framework. Therefore, the framework mentioned here is limited in the way that can correspond only to the adaptation criteria from Böckle's classification.

In this section, we will focus on how gamified learning environments can change to suit each person's needs. Taking prior studies into consideration, a structure has been established for this study. While establishing our structure, we drew inspiration from Böckle et al.'s (2018) design framework, which was influenced by Specht and Burgos's

(2007) questions. We will discuss adaptive gamification through the following structure consisting of four main elements (Table 1):

(1) *Adaptation criteria* serve as the basis for determining how adaptations will be implemented. It includes the information that will be used by the system for adaptation such as player types, personality models and learning styles.

(2) *Adaptation process* focuses on outlining how the adjustment will take place and includes dynamic and static adaptation.

(3) *Adaptation data* is about information collection methods about the learners.

(4) *Adaptation intervention* is the stage where practical steps of adaptation occur. It mainly includes recommendations, giving personalized feedback, and adapting gamification design elements and mechanics.

Table 1

Adaptive Gamification Structure

Adaptation criteria	Adaptation process	Adaptation data	Adaptation intervention
● Player Type ○ BrainHex ○ Hexad ○ Bartle ● Personality Models ○ Myers-Briggs Type Indicator ○ Five Factor model ● Learning Style ○ Felder-Silverman ● Hybrid Models	● User controlled ● System controlled ○ Static adaptation ○ Dynamic adaptation ○ Static+Dynamic adaptation	● Explicit information collection ○ Self-reports ○ Self-assessments ○ Responses to test items ○ Knowledge assessments ○ Questionnaires ○ Scales ● Implicit information collection ○ System logs/interactions ○ Sensor-based information	● Recommendation ● Personalized feedback ● Adapting game mechanics and elements

Adaptation Criteria

This section focuses on the elements that form the basis of adaptation. Researchers based their adaptation on several elements including player types, personality models, learning styles and hybrid profiles.

Player Types

In adaptations based on player type, Bartle, BrainHex and Hexad player typologies are frequently preferred.

In Bartle's (1996) classification for multi-user virtual worlds, players are categorized into four groups as achievers, explorers, socializers, and killers. Accordingly;

- *Achievers* enjoy acting in the game world and play to win.
- *Explorers* enjoy interacting with the game world and like to explore.
- *Socializers* enjoy interacting with the other players and spend their time chatting.
- *Killers* enjoy acting on other players and like to dominate them through bullying or strategic behaviors.

In the study conducted by Kocadere and Çağlar (2018), Bartle's player types were chosen to investigate the relationship between player types, game components, and mechanics. The study revealed that the mechanics and components that influence learners vary based on their player types. Furthermore, the game components triggering specific mechanics show differences according to player types, subsequently impacting the entire design process. Meanwhile, researchers examining whether learners' flow experiences differ based on player types and gender did not find a significant distinction in the flow experiences among different player types and genders (Marinho et al., 2019).

Kırmacı and Çakmak (2024) developed an Online Gamified Learning Environment and examined the impact of these environments on learners' engagement, motivation, and participation. In the experimental group of the study, students were presented with scenarios tailored according to Bartle player types, while students in the control group participated in an Online Learning Environment without gamification elements. Although there was no significant difference in terms of engagement and motivation scores between the experimental and control groups, it was observed that learners' participation and interaction increased in the experimental group.

Considering Bartle's classifications are specific to Multi-User Dungeons (MUDs) and should not be extended to other game genres or gamified designs, Marczewski (2015) developed a gamification-specific framework called Hexad. The framework is grounded in human motivation, player types and practical design experiences. The player types and the motivating factors for them explained by Hexad can be summarized as follows:

Philanthropists are motivated by a goal. They have an altruistic nature and are willing to give without any expectation of reward.

Socializers are motivated by being related. They like to interact with others and build social bonds.

Free Spirits find motivation in the freedom of self-expression and acting without external control, known as autonomy.

Achievers are motivated by competence. They aim to progress by completing the tasks within a system and to prove that they can overcome tough challenges.

Players find motivation in external rewards. They are willing to do whatever it takes, regardless of the activity, to earn a prize.

Disruptors are motivated by the triggering of a change. While they may tend to directly disrupt the system, they sometimes force others to make positive or negative

changes. They like to test the limits of the system. Disruption is not always negative but can have a positive effect on the development of the system.

The reasons why Hexad is recommended by the researchers are mainly because of the fact that it was developed specifically for gamification and validated (Hallifax et al., 2019b; Knutas et al., 2019; Tondello et al., 2016). The development, validity, and reliability study of the Hexad model and the scale devised to determine user preferences within this model were carried out by Tondello et al. (2016) and game components were suggested for each user type. Additionally, in a study investigating the relationship between various user models and game components to identify the most relevant model for determining users' game component preferences, researchers (Hallifax et al., 2019a; Hallifax et al., 2019b) concluded that Hexad was the most effective model for determining user preferences and its descriptions of user types were consistent. In addition, the application of motivational strategy and the choice of user typology are shown as two major factors affecting motivation in adapted gamification.

Another model that researchers preferred is the BrainHex model developed by Nacke et al. (2014). Building on previous player classifications and neurobiological studies, this model has seven player archetypes: Seeker, Survivor, Daredevil, Mastermind, Conqueror, Socializer, and Achiever. The reason why they were named archetypes was stated by the developers of the model as follows: “Each category within BrainHex should be understood not as a psychometric type, per se, but as an archetype intended to typify a particular player experience, which can thus be understood as a qualitative presentation of an underlying implicit trait framework.” (Nacke et al., 2014, p.58). Here are the summarized details regarding these seven archetypes:

Seeker: These people are motivated by interest mechanisms, are curious about the game world and enjoy these moments of curiosity.

Survivor: People in this archetype enjoy negative emotions such as fear and horror, at least in a fictional context like games and movies.

Daredevil: This group's gaming style is centered around the thrill of pursuing and taking risks, usually playing on the edges.

Mastermind: For the individuals of this archetype, the essence of enjoyment lies in dealing with puzzles that require problem-solving and strategy. They enjoy solving puzzles and developing strategies, as well as focusing on making the most efficient decisions.

Conqueror: Individuals of this archetype are not content with easy victories, want to fight hard until victory, and enjoy beating other players.

Socializer: This archetype includes people whose primary source of entertainment is people, who enjoy talking to people, helping them, and spending time with people they trust.

Achiever: While the Conqueror archetype is challenge-oriented, the Achiever archetype is goal-oriented and motivated by long-term successes. This difference might be subtle, but it is significant. (Nacke et al., 2014)

Lavoue et al. (2019) examined the relationship between BrainHex player types and game elements and revealed that adaptive gamification can significantly enhance the participants of students who use the environment for the longest time, and it can also

reduce students' levels of amotivation compared to non-adaptive gamification. In addition, since the adaptation is more effective on those who spend the most time in the system, the researchers suggested that the elements that keep the participants in the system should be included.

Daghestani et al. (2020) examined whether classifying learners according to their navigation in the system and adapting gamification according to player types increases the effectiveness of e-learning environments. They adapted the design based on BrainHex player types and students were divided into a control group and two experimental groups. While the students in the control group were provided with a non-gamified system, one of the experimental groups with a gamified system and the other one with a gamified system adapted according to player types. The results suggested that gamification had a positive effect on students' engagement and performance, and students exposed to adaptive gamification had better engagement and performance.

Oliveira et al. (2022) investigated whether tailoring gamification according to students' player type had an effect on their flow experience, enjoyment, gamification perception and motivation. Students were divided into seven groups according to BrainHex player types and students in each group were randomly assigned to experimental and control groups. The study was conducted using a within-subject factorial design, and all participants experienced both personalized and non-personalized situations. The study concluded that personalization did not have a significant impact on learners' flow experience, enjoyment, perception of gamification, and motivation. In fact, it was found that the Socializer, Seeker, and Achiever player types enjoyed the non-personalized gamification environment more. Furthermore, the Conqueror and Daredevil player types had more fun in the non-personalized environment, but their perception of gamification was higher in the personalized environment. On the other hand, the Survivors' motivation and perception of gamification was high, but the feeling of enjoyment is the same with the non-personalized environment. According to researchers the reason why the personalized gamification did not yield expected results may be because of low-level personalization, focusing on the dominant player type, using a player typology specific to games, participants' age or gender. Additionally, although the data collection tools are valid and reliable, BrainHex is not a valid tool and spending 30 minutes before responding to surveys may have caused tiredness in students and may not be enough to experience flow (Oliveira et al., 2022).

Personality Models

Another factor considered in the adaptation of gamification is personality models. Based on Carl Jung's psychological types, the Myers-Briggs Personality Indicator has four dimensions: Extraversion-Introversion, Sensing-Intuition, Thinking-Feeling and Judging-Perceiving (Bayırlı et al., 2019; McCrae & Costa, 1989; Zaric et al., 2017). González et al. (2016) proposed a model referred to as gITS (Gamified Intelligent Tutorial System), which integrates artificial intelligence techniques and incorporates game elements, and personalization features. They chose the Myers-Briggs Type Indicator as part of their approach to determine personality types and tailor the gamification experience accordingly.

Additionally, the Big Five Model / Five Factor Model is another model preferred by researchers. As the name implies, this model includes five dimensions: Neuroticism, Extraversion, Openness, Conscientiousness, and Agreeableness (McCrae & Costa, 1989). Each of the five dimensions represents a broad spectrum of traits or tendencies. Neuroticism involves a tendency to experience negative effects such as anxiety, anger, and depression, while extraversion encompasses sociability, activity, dominance, and experiencing positive emotions. Openness is associated with imagination, aesthetic sensitivity, emotional depth, curiosity, and a need for diversity. Agreeableness includes sympathy, trust, cooperation, and altruism. Conscientiousness encompasses organization, perseverance, meticulousness, and a need for achievement (McCrae & Costa, 1989).

Codish and Ravid (2014) focused primarily on extraversion and introversion of the Five Factor Model and concluded that people with different personality traits differ in terms of enjoyment of game elements and perceptions of games. Similarly, Jia et al. (2016) demonstrated that personality traits can influence the acceptance (or rejection) of a gamified implementation depending on the motivational elements used. The study also showed that extroverts tend to be motivated by points, level and leaderboard; individuals with high levels of openness were less likely to find motivation in avatars.

Learning Styles

Another aspect favored in adaptation of gamification is learning styles. Hassan et al. (2021) preferred Felder-Silverman model to adapt an e-learning platform due to its appropriateness for e-learning platforms and established validity and reliability compared to other models. The study investigated the impact of adaptive and non-adaptive gamification on learners' course completion, performance, and motivation, revealing that adapted gamification led to a significant increase in these variables. The Felder-Silverman model categorizes learning styles into four dimensions: (1) Visual-Verbal, (2) Active-Reflective, (3) Sensing-Intuitive, and (4) Sequential-Global. As noted by Felder and Silverman (1988), these four dimensions are not entirely unique or exclusive, as some dimensions align with those found in other well-known models.

Altaie and Jawawi (2021) provided an adapted gamification framework aimed at enhancing information processing skills of children aged 8-13, and their study showed that gamification tailored to Felder-Silverman learning styles not only increased learners' motivation but also raised their willingness to retake quizzes they could not complete, potentially leading to improved performance.

Hybrid Profiles

Although player types are commonly preferred for adapting gamification, some studies have combined player types with personality models, motivation levels, individual preferences, and demographic characteristics.

Hallifax et al. (2020) based their studies on students' motivation profiles in addition to player types. 258 students in a gamified learning environment were assigned a random game element without tailoring, and students’ motivation, player types and engagement metrics were collected while they were using the system. They used the Academic Motivation Scale by Vallerand et al. (1992) to define students’ motivation. The scale addresses motivation in seven sub-dimensions and evaluates intrinsic

motivation, extrinsic motivation and amotivation. These seven dimensions are as follows:

(1) Intrinsic Motivation for Knowledge: Engaging in an activity solely for the joy and fulfillment of experiencing something novel.

(2) Intrinsic Motivation for Accomplishment: Participating in an activity for the delight of overcoming a difficulty.

(3) Intrinsic Motivation Stimulation: Participating in an activity for the sake of enjoyment or excitement.

(4) Extrinsic Motivation External Regulation: Taking part in an activity to get external rewards.

(5) Extrinsic Motivation Introjected Regulation: Engaging in an activity to prevent feelings of shame or enhance self-esteem.

(6) Extrinsic Motivation Identified Regulation: Engaging in an activity to reach specific goals.

(7) Amotivation: Lack of intention to engage in an activity.

After obtaining learner data, three different adaptation simulations were analyzed: (1) Hexad user profile, (2) initial motivation user model, and (3) a combined model called the dual model. For each adapted profile, affinity matrices were created to determine how each profile influenced the preference of game components, and game components were assigned based on each profiles' values on the affinity matrix. A total of 10 lessons were conducted, and after the final lesson, students filled out the motivation scale once again. The difference between the learners' intrinsic motivations, extrinsic motivations, and amotivation before and after the implementation was examined, and it was concluded that dual adaptation increased the learners' intrinsic motivation compared to adaptation based on motivation profiles alone (Hallifax et al., 2020).

Chtouka et al. (2019) aimed to adapt the gamified learning management system with the help of machine learning and created a new Learning Player Profile by presenting a model that combines Felder-Silverman learning styles and BrainHex player types. Based on this new profile, the learning management system has adapted itself according to learner characteristics. Researchers examined the consistency of the system's adaptation with learners' responses to player type and learning style scales and revealed a 77.5% level of consistency. They stated that this approach will optimize the efficiency of adaptation as it allows to adapt learning and gamification at the same time. Details about the eight newly created profiles, formed by considering shared attributes of learning styles and player type models, are as follows:

(1) *The sensing/seeker* prefers gamified learning paths that include tangible materials like exercises and examples.

(2) *The intuitive/mastermind* enjoys challenges and collecting stars, favors a limited number of diagrams and exercises as their main interest lies in learning from abstract materials and solving challenges.

(3) *The visual/survivor* enjoys lessons that utilize diagrams, visuals, and videos to understand objects.

(4) *The verbal/survivor* likes explanations, requiring plenty of learning segments, narrations, and examples.

(5) *The active/socializer* prefers learning by doing, actively engaging in hands-on experiences to acquire knowledge.

(6) *The reflective/conqueror* enjoys reflecting upon learning materials and concepts learned at the end of a lesson.

(7) *The sequential/achiever* prefers spending time mastering materials and step-by-step practices of learned concepts.

(8) *The global/daredevil* prefers to advance through a lesson without necessarily completing every step, seeking challenges by skipping certain steps.

There are a few more studies to combine more than one feature to adapt gamified environments (Klock et al., 2020) such as behavior-performance (Utomo & Santoso, 2015), age-gender-player type-personality traits (Tondello et al., 2017).

Considering learners' performance and behaviors within a gamified environment, Utomo and Santoso (2015) personalized feedback for learners through four distinct pedagogical agents they designed. They concluded that the personalized experience had positive effects on learners' active learning behavior and motivation, and learners were satisfied with the recommendations tailored to themselves.

Tondello et al. (2017) categorized the most commonly used game elements into eight main categories considering user preferences: (1) Socialization, (2) Assistance, (3) Immersion, (4) Risk/Reward, (5) Customization, (6) Progression, (7) Altruism, and (8) Incentive. They investigated how user characteristics such as age, gender, player type, and personality traits influenced the scores within these categories, aiming to establish an adaptation framework that appeals to diverse user profiles. They used Hexad for determining player types and Five Factor Model for personality traits. The study has yielded following results:

- Socialization elements are favored by men, individuals with socializing tendencies, and extroverts.
- Assistance elements are preferred by women and extroverts.
- Immersion elements are favored by females, achievers, and free spirits.
- Younger achievers and players tend to favor Risk/Reward elements.
- Customization elements attract younger women who exhibit greater openness to new experiences.
- While the reasons behind progression preferences are not explicitly clarified by any studied variables, achievers and philanthropic individuals tend to like them more than others.
- Younger males, philanthropic individuals, socializers prefer altruism elements.
- Incentive elements are more appealing to younger players who have higher neuroticism scores on the scale.

Adaptation Process

In this section, we explain how adaptation occurs, involving both dynamic and static adaptation processes, as well as their combination, and how it is controlled, by

system or user. We address the adaptation process in two sections: user-controlled adaptation and system-controlled adaptation.

User-Controlled Adaptation

Adaptation process can be controlled by the user or by the system. If the personalization is user-initiated (Tondello & Nacke, 2020) or user-controlled, it is also called customization. In customized gamification learners have option or control to change the design. Lessel et al. (2016) offered users the freedom to choose what, when and how aspects will be gamified. Similarly, Tondello and Nacke (2020) compared a one-size-fit-all approach (control group) with a customized version (experimental group). Participants in the control group were all assigned the same game elements, while the participants in the control group were asked to choose from the eight game elements as many as they wanted to see in the design.

System-Controlled Adaptation

Personalization can also be controlled by the system. System-controlled personalization or system-initiated personalization is a process in which the system takes the initiative to select game design elements for users with or without using inputs from the users (Tondello & Nacke, 2020). This process is detailed as dynamic and static adaptation in the following section.

Dynamic and Static Adaptation. Current adaptation studies commonly use static adaptation which determines the user's state (player profile, game preferences, motivation, personality traits, etc.) only once and does not take into account changes that may occur in users during the use of the gamified platform (Hallifax et al., 2021). On the other hand, dynamic adaptation uses the information obtained from the user as a first step and then updates the user profile by following their interaction with the system and their behavior in the system (Hallifax et al., 2021; Rodrigues et al., 2022). Researchers aimed to automate the adaptation and address the challenges of achieving effective gamification design and adapting systems to each user by making use of machine learning and learning analytics in the dynamic adaptation process (Hallifax et al., 2021; Knutas et al., 2019).

Lavoue et al. (2019) presented a model that automates the adaptation of a learning environment used to teach French grammar and spelling based on player profiles. They adapted the learning environment in two ways: adapting the content and adapting the gamification. One of the game components included in the system is the stars that learners earn when they learn each grammar rule. Another component used is the leaderboard which is designed to show neighbors' performance rather than top performers. The effect of this 3-week implementation on learners' participation in the learning environment and motivation was investigated. Participants were divided into three groups; the first group received two adaptation elements most suitable for their BrainHex profiles, the second group received the least suitable two elements (counter-adaptation), and the third group did not receive any game elements. Analyzing the time learners spent in the system revealed that the use of adapted game elements increased engagement and led learners to spend more time in the system, while the group with counter-adaptation spent an average amount of time as the group without any game components. In terms of enjoyment, game components did not make a difference.

Dynamic adaptation does not necessarily mean full automation of adaptation. As in the study by Monterrat et al. (2015), it can also be applied by creating a profile at the beginning with the static adaptation approach and then changing the design according to the changes in the system movements. Halifax et al. (2021) proposed a model by using dynamic and static approaches together. In the static adaptation phase, learner profiles are created using certain tools before students start using the gamified system, and game components suitable for these profiles are integrated into the system. The next step involves tracking learners' behaviors in the system and recommending game elements to teachers to re-engage their students when their engagement drops.

Adaptation Data

In order to adapt gamification for different individuals, it is necessary to gather information about the learners, so this section focuses on how this information is collected.

There are several ways to gather information about learners for adaptation such as knowledge assessment, tests, questionnaires, user tracking and user model inference (Specht & Burgos, 2007). Jameson (2002) explores the collection of information about users, primarily emphasizing two categories: explicit and implicit methods. Explicit method includes the type of information that the learner provides explicitly for the system. On the other hand, the information obtained implicitly includes all user actions within the system that are not intended to reveal information about the user to the system (Jameson, 2002). In the following lines, we will also address information collection in two categories, explicit and implicit.

Explicit Information Collection

As Jameson (2002) mentioned self-reports, self-assessments, responses to test items, similarly Specht and Burgos (2007) mentioned that knowledge assessments, and questionnaires are categorized under explicit data collection. Examples include the scales employed to identify player types (Chtouka et al., 2019; Daghestani et al., 2020; Hallifax et al., 2019a; Lavoue et al., 2019; Oliveira et al., 2022; Tondello et al., 2016), learning styles (Altaie & Jawawi, 2021; Chtouka et al., 2019; Hassan et al., 2021), personality models (Codish & Ravid, 2014; Jia et al., 2016) or motivation profiles (Hallifax et al., 2020) in the studies.

Implicit Information Collection

Tracking the learners' actions that occur naturally within the gamified environment and sensor-based information (e.g. eye tracking) are kind of data obtained within the system implicitly (Jameson, 2002). This data may include their navigation paths, frequency of engagement, time spent on specific tasks, or the choices made within the system (Specht & Burgos, 2007). Hassan et al. (2021) used interactional data for adaptation. In their study, the system logs student interactions (type and duration) in the interaction log linked to their ID and stores information in the student model. Then, the system called "Learning Type Identifier" uses this data to create personalized profiles, and determine each student's learning dimension using these profiles (p. 550).

Bennani et al. (2022) employed machine learning algorithms to create learner profiles and adapt gamification dynamically based on the created profiles. Similarly,

Knutas et al. (2019) presented an algorithm-based personalized gamification system and showed how to use machine learning algorithms to adapt gamification dynamically according to learners' characteristics. Daghestani et al. (2020) created a system which combines educational data mining techniques, namely classification, gamification and adaptation. For the adaptation process, the system classified students using students' interaction data extracted from Moodle, and player types obtained by BrainHex questionnaire. López and Tucker (2018) introduced a machine learning method that predicts an individual's performance in a gamified task by using task-related information and facial expression data. Then the collected data was used for creating an "adaptive-individual-task" model and predicting individuals' performance in gamified tasks.

Adaptivity Intervention

Adaptive interventions involve gamification features that serve as interventions reflecting the outcomes of the adaptation process at the interface level (Böckle et al., 2018).

Common interventions include the delivery of suggestions and advice aimed at updating end users on their individual learning progress (e.g., notifications for deadlines, personalized feedback) and adaptation of game design elements and mechanics (Böckle et al., 2018). Providing personalized feedback or visualizing the feedback process, such as using dashboards that include the learner's current state and offering recommendations could be an example of adaptive intervention in gamified learning environments (Bayrak et al., 2021; Maher et al., 2020). Altaie and Jawawi (2021) implemented adaptive gamification on Moodle. They classified students based on the visual-verbal dimension of Felder-Silverman Learning Style. Both groups received the same learning materials; however, visual learners were presented with additional graphical materials, whereas verbal learners were given more textual materials. In addition, the game elements differed, with visual learners receiving progress bars, levels, badges, points, goals, teamwork, and feedback, while verbal learners were provided with points, challenges, teamwork, and feedback. Chtouka et al. (2019) aimed to adapt a gamified learning management system using a machine learning algorithm. The algorithm went through several iterations to find and suggest the optimal path that aligns with the learners' profile.

Conclusion and Suggestions

This study covers the fundamentals of gamification and sheds light on the current developments and potential direction of gamification studies. Our review shows how gamification is transitioning towards more adaptive forms to meet diverse learner needs and features. Studies have focused on the necessity of adaptive gamification in education to improve students' learning, achievements, and enthusiasm (Bennani et al., 2022). Specifically, research has demonstrated that adaptive gamification positively impacts various aspects of the educational experience. For instance, it has shown to enhance student engagement (Lavoue et al., 2019; Daghestani et al., 2020), participation (Kırmacı & Çakmak, 2024; Lavoue et al., 2019), and interaction (Kırmacı & Çakmak, 2024). Furthermore, adaptive gamification has been linked to increased motivation (Altaie & Jawawi, 2021; Hallifax et al., 2020; Utomo & Santoso, 2015) and higher

levels of satisfaction (Utomo & Santoso, 2015). These findings emphasize the potential of adaptive gamification to create more engaging and effective learning environments.

However, the terms used in the adaptive gamification context are used interchangeably and lack strict differentiation. In this regard, we examined literature and provided detailed definitions of the terms adaptive gamification, tailored gamification, personalized gamification, customized gamification, including adaptive and adaptable systems. To sum up, personalized gamification is a broad term covering any adjustments in the gamification design to address different learner needs and aspects. In customized gamification, the change(s) is made by the user/learner. While in tailored gamification the adjustments are made at the initial phase, in adaptive gamification the adjustments are dynamic and made by the system throughout the implementation process. So, it becomes evident that tailored gamification aligns with static adaptation, where adjustments are predetermined and implemented at the beginning. In contrast, adaptive gamification corresponds to dynamic adaptation, reflecting the system's ongoing adjustments throughout the implementation process.

In order to analyze how adaptive gamification studies are designed and what these designs are based on, we looked into studies through four main points: adaptation criteria, adaptation process, adaptation data and adaptation intervention. Adaptation criteria outline the basis on which the adaptation will be made. It includes player types, personality models, learning styles and hybrid profiles. In the examined studies, Bartle (Kırmacı & Çakmak, 2024; Kocadere & Çağlar, 2018; Marinho et al., 2019), Hexad (Hallifax et al., 2019a; Hallifax et al., 2019b; Tondello et al., 2017) and BrainHex (Chtouka et al., 2019; Daghestani et al., 2020; Lavoue et al., 2019; Oliveira et al., 2022) player typologies were utilized for categorizing player types, the Big Five Model / Five Factor model (Codish & Ravid, 2014; Jia et al., 2016; Tondello et al., 2017) and Myers-Briggs Type Indicator (González et al., 2016) were employed as the basis for personality modeling, and the Felder-Silverman model (Altaie & Jawawi, 2021; Chtouka et al., 2019; Hassan et al., 2021) was used to define different learning styles. Moreover, in some studies (Chtouka et al., 2019; Hallifax et al., 2020; Klock et al., 2020; Tondello et al., 2017; Utomo & Santoso, 2015) hybrid profiles were utilized for adaptation and integrating multiple aspects. Regarding the adaptation process, it goes through user-controlled or system-controlled adaptation. User-controlled adaptation is giving users the opportunity to control the adaptation process, and it is called customization. On the other hand, system-controlled adaptation processes are discussed under dynamic, static, or sometimes a combination of these approaches. In order to collect data for adaptation, researchers utilized various resources including questionnaires, scales, system logs and machine learning algorithms. Lastly, most of the studies adjusted game design elements and mechanics aiming intervention.

Lastly, reviewing existing studies also underlined framework limitations, insufficient number of empirical research, concerns related to automation and different use of terminology. It is stated that adaptive gamification is gaining popularity, but existing frameworks offer initial insights, and there is a need for comprehensive and in-depth research and development of standardized frameworks and guidelines for the implementation of adaptive gamification (Bennani et al., 2022; Oliveira et al., 2023; Rozi et al., 2019;). Clear and universally accepted models can offer a structured approach, ensuring better design and application of adaptive gamification strategies in

different settings. For sustaining adaptation and automation of the adaptive process, gamification analytics should be employed. This review, by synthesizing existing knowledge and identifying research gaps, serves as a foundation for future investigations in this field.

Acknowledgements

The authors received no financial support for the research, authorship, and/or publication of this article.

Statement of Responsibility

The manuscript is part of the first author's PhD thesis under the close supervision of the second author.

Conflicts of Interest

The authors report there are no competing interests to declare.

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