



# Incorporating the Theory of Attention in Applied Game Design

Isabelle Kniestedt<sup>1</sup>(✉), Stephan Lukosch<sup>2</sup>, Milan van der Kuil<sup>3</sup>, Iulia Lefter<sup>1</sup>,  
and Frances Brazier<sup>1</sup>

<sup>1</sup> TPM, Delft University of Technology, Delft, The Netherlands  
ikniestedt@gmail.com

<sup>2</sup> HIT Lab NZ, University of Canterbury, Christchurch, New Zealand

<sup>3</sup> Trimbos-instituut, Utrecht, The Netherlands

**Abstract.** Whereas entertainment games are capable of creating deeply rewarding and emotional experiences, applied game projects often result in products that, while potentially effective, are lacking in many other aspects of the user experience. This may be due to the fact that the focus of most design approaches for applied games lies primarily on the use of game mechanics, neglecting other aspects of design that aim to shape and influence the player’s emotional journey. This article provides an exploratory effort in a different approach to creating applied games, namely through the design of user attention and by integrating the theory of attention into applied game design practice. This approach is tested in two ongoing applied game projects, from which preliminary guidelines for applied game researchers and practitioners are proposed.

**Keywords:** Applied games · Serious games · Game design · Attention

## 1 Introduction

The design of games for non-entertainment purposes (referred to as ‘applied’ games in this article) is a continued topic of discussion within academic discourse. Frameworks for applied game design, intended to support the development of such games, tend to focus on defining conceptual factors that play a role in the design process [44]. Some factors are well understood, such as the importance of defining the learning content (i.e., the intended skills or knowledge to be gained) [3, 10, 23] or defining the intended user’s existing needs, interests, experience and skills [9]. Connections have also been made between these aspects and the intended design of the applied game. It has, for example, been suggested that a game genre (e.g., ‘strategy’ or ‘action adventure’) should be chosen following previously established needs [3, 29, 46]. This, in turn, should then lead to the inclusion of genre-appropriate rules and game mechanics [44].

Games offer players agency through actions – it is one of the primary factors that sets them apart from other forms of media [21]. As such, it is not surprising that applied game design efforts tend to focus on mechanics (i.e., actions that can be taken to interact with the game world) and their corresponding systems (e.g., feedback mechanisms) [38]. This type of approach has resulted in work focused on establishing the value of specific mechanics and their effect within an applied game or for a specific audience (e.g., [16,18,35,36], with the goal of creating an easy to use ‘catalogue’ of mechanics that can be applied to any purpose. This is not unlike gamification efforts, however, where the same game elements are applied to any context [17]. Similar to how gamification has been criticised for oversimplifying how games function [20] by mistaking incidental properties of games (e.g., leaderboards, points) for primary features (i.e., complex, meaningful interaction) [4], this article argues that applied game design approaches singularly focused on mechanics risk falling into the same trap. The result of such approaches are games that similarly ignore important aspects of the player’s emotional experience.

With the entertainment game industry producing vast amounts of easily accessible games, resulting in a growing game literacy among audiences, overly simplistic game designs may not remain engaging (and, thus, effective in achieving their purpose) in the future [7]. For this reason, applied game practitioners should continue to adopt knowledge and techniques from entertainment game design. Naturally, there are many approaches to game design. This article provides an exploratory attempt to incorporate one such an approach, and does so by **mapping and adopting the theory of attention** from entertainment game design to that of applied games.

One popular design approach within entertainment games has been that of design ‘lenses’ [37], which can be used to evaluate design decisions from different perspectives at various stages of development. **This article proposes a new lens for applied games: the lens of attention.** Within games, attention can be directed through design decisions [5]. These range from granular decisions, such as the presentation of feedback or design of user interfaces, to more comprehensive choices that determine the structure of the game.

The following section provides an **overview of the underlying theory of attention**, and how it factors into game design. This theory is then used to **extend existing models of applied game design and engagement**, and used to **guide design discussions in two applied game projects**. From these discussions, the article outlines **preliminary guidelines to designing applied games with attention**.

## 2 Related Work

‘Attention’ refers to a sustained focus of cognitive resources on information while filtering extraneous information [40]. It is considered a basic function that is a precursor to all other cognitive functions. Particularly important to the subject of this article are *reflexive attention* and *selective attention*, as well as the related term of *vigilance*.

Reflexive attention, also known as stimulus-driven attention, describes a person’s ability to respond to specific sensory stimuli [33]. It is driven by the properties of objects (e.g., movement or sound) and is a largely autonomous process—attention is drawn to such stimuli whether a person wants to or not. Selective attention refers to the aspect of attentional processing that is under a person’s control [13]. Attention is a limited resource - a person cannot pay attention to everything at once or for an unlimited time. Vigilance refers to the ability to respond to events in the environment, which decreases over time as a result of fatigue due to cognitive load [33]. Techniques such as switching attention to another stimulus can mitigate these negative effects.

Attention plays a role in game design in many ways. The most established is in that of user interface (UI) design, and how information is presented to the player [2,37]. Important information is shown in the player’s direct view, accompanied by sound and visual indicators to draw (reflexive) attention. Less critical elements are distributed at the edges of the screen to let a player focus on them if required (selective attention). Designers may also shape the environment, use lighting, or place objects to alert players to specific areas of the game, elicit curiosity, or guide them towards goals [15]. While important, this use of attention is not the primary focus of this article. Instead, this section will introduce two other aspects in which attention plays an important role, which have not yet been incorporated into applied game design: **areas of involvement** and **balance and rhythm**.

## 2.1 Areas of Involvement

Calleja [5] proposes **six general areas of involvement within a video game**; ludic (gameplay), spatial, kinaesthetic (movement), narrative, shared (social), and affective (emotional). Games provide a combination of these areas, and attention shifts between them from moment to moment. Kinaesthetic involvement (i.e., involvement from the act of controlling an avatar) may be dominant during a challenging platforming section, but shifting to affective involvement when appreciating the view. Deciding when to heal during a combat encounter or reading enemy attack patterns are examples of ludic involvement, while the player is also still concerned with dodging incoming attacks (kinaesthetic). In such moments, the player’s attention is more likely to be ‘saturated’, and they are unlikely to admire the scenery. **When and how to shift the player’s attention is essential in structuring the game experience.** For example, developers at CDProjekt Red devised a ‘40-second rule’ when developing *The Witcher 3* [6], determining through play tests that players should see something of interest (e.g., a pack of deer, opponents, an NPC) every 40s of exploring the world in order to stay engaged [39]. A more simplified version of the areas [26] is that of **gameplay** (ludic, spatial, and kinaesthetic), **social** (narrative and shared), and **affective** (emotional experience) (Fig. 1).

**Different areas of attention are considered more or less effective than others in capturing and maintaining attention** [26] Mechanics, controls, and spatial design pose an entry barrier that players need to invest time and



**Fig. 1.** In *Zelda: BotW* [32] the player’s attention frequently shifts between, e.g., affective (a beautiful vista), gameplay (learning controls), and social (meeting an NPC).

energy in. Mechanics that are deep enough, however, can maintain attention for a long time. Narratives and characters neither capture nor hold attention very well; while people are drawn to them, it is challenging to write them in a way that are both quickly understood and remain interesting [1]. Finally, elements aiming at affective involvement capture attention well (e.g., through art style, music, and sound design), but are less likely to hold attention unless the game offers other elements of substance.

Depending on the game, the balance between the areas of involvement varies. A platforming game may not involve many narrative or social aspects, while a game focused on creating an affective experience through sound and visuals may have simple mechanics. However, it is reasonable to say that a balance is usually required in creating a unified experience [37].

## 2.2 Balance and Rhythm

Attention factors into game design in two major ways; in repeatedly capturing a player’s attention from moment to moment (reflexive) and in maintaining that attention by offering depth within and variety between game areas (selective). It is furthermore necessary to be aware of overloading the player cognitively through too much information (vigilance), or under-stimulating them by staying within one area for too long. Designing with this knowledge in mind leads to the creation of rhythm or the ‘emotional beat’ in a game [27,37].

Flow theory states that a pleasant state of enjoyment is reached when a person’s skill and the challenges provided by a task are in balance. This theory is often used in relation to games, as games are considered suitable vehicles for inducing a flow state [41]. It would be incorrect to assume, however, that games simply provide a stream of challenges that continuously matches the player’s skill level. Modern games provide a wide variety of experiences, including moments of (extreme) challenge. This can be highly entertaining, memorable, and engaging. The popularity [34] of the recent release *Elden Ring* [14] - a game developed by FromSoftware, a studio notorious for creating difficult games - provides a good example of this. In games like this, moments of high intensity (e.g., an encounter with a seemingly insurmountable enemy) are balanced with moments of respite (e.g., exploring, crafting, interacting with characters). This is the case

within the overarching game structure (in which major enemy encounters are balanced with longer sections of exploration, affective experiences, and other or lower-intensity gameplay) and on a more granular level, such as in the design of specific areas. **Together, these moments form the ‘rhythm’ of the game, offering memorable highs and lows in the player’s experience.**

There is no universal standard for what this rhythm should be and it will vary depending on the game. Missions in *Uncharted 3* [30], for example, follow a three-act structure similar to movies [26, 27]. Naturally, there are also games that aim for a pleasant ‘middle’ experience, in which a player never has the feeling that they can’t overcome the obstacles presented to them. Examples of these are zen-like games (e.g., *Flow* [42] or *Flower* [43]), puzzle games (e.g., *Monument Valley* [45]), or simulation games (e.g., *Animal Crossing* [31] or *Stardew Valley* [8]). However, it is important to note is that, even in these experiences, there are still variations in attention demand and a switching of attention between different areas (e.g., talking to characters, admiring visuals or music, movement, or (light) combat mechanics).

These are only some examples in which attention is manipulated through design in order to shape a player’s experience. Game designers use everything at their disposal, including mechanics, environments, motion, stories, characters, lighting, visuals, and sound to grab and hold a player’s attention, to offer depth and variation, and to structure and balance the player experience. This happens on different levels, both in the overall game structure and from moment to moment. In doing so, **designers take care not to saturate players with different types of information, but rather use the various aspects of design to enforce a defined and coherent player experience.**

### 2.3 Attention in Applied Games

Attention is not a novel concept in the applied game literature. As mentioned previously, it has been used in relation to UI design and the presentation of information [44]. Outside of this, however, it has primarily been used to explain other concepts, such as immersion [19]. Attention is considered a first level of, or stepping stone towards higher levels of immersion, but not core to game design.

One exception is the Applied Games Engagement Model (AGEM) [25]. AGEM differentiates between **game systems**, and **everything that is meant to fulfil an intentional, non-entertainment (applied) purpose**. This may include **elements external to the game**, such as the physical environment and facilitators. **Together, they form the entire game experience**. Attention is directed through design decision and shifts between the game systems and the applied purpose. In general, there should be a sense of **overlap** between the two, although the overlap may vary throughout the game. At times, attention may be directed away from the game systems altogether to facilitate moments of reflection.

The theory proposed by AGEM is similar to the theory of attention for applied games, in which a player’s attention is guided between areas of attention. It is, however, a theoretical model that has not yet been tested in practice. This

article addresses this gap and assesses the extent to which the model is fruitful in practice.

### 3 Implementation

To design the game systems of an applied game, this article presumes that the theory of attention outlined in Sect. 2 can be of use, as long as the applied purpose is taken into account. This section describes how this was done in practice. Stakeholders from two applied game projects (Fig. 2) participated in guided design discussions. Both projects were ongoing at different institutions; they were not ‘created’ for this article. Each of the projects had gone through a design and development cycle, resulting in a prototype. The projects were then continued by different people than the original developers. The new developers identified issues with the existing design. During the discussions, they used the theory of attention to address these perceived issues. In the interest of scope, this article does not go into detail on the design of the games, but only uses examples to illustrate how the theory was applied. The two cases provided here were selected based on convenience and availability. However, the projects presented can be considered representative of a larger selection of applied gaming projects.

#### 3.1 Case 1: Virtual Reality (VR) Person-Centred Care (PCC)

The first case study has been developed by the Trimbos-institute, with the aid of an external applied game development studio. It is VR training software for health workers caring for people with dementia. It aims to train players in person-centred care [11] by placing them in the role of a carer working in a nursing home. During the game, the player is presented with narrative scenarios that are to be resolved by choosing one of several options. One the options is considered to be the only correct answer based on the principles of person-centred care. Players are informed of how successful they are at the end of the scenario through a score, and given further relevant information on the topic of person-centred care. Throughout the game, players complete several, primarily text-based, scenarios. The game utilises a realistic 3D art style, using sound and simple animations to emphasise the actions of the characters.

The project was inactive for some time until it was picked up by a new stakeholder. Issues with the original design were primarily related to the game being “not very much like a game”. Especially the allocation of points and restrictive nature of the scenarios were considered inadequate for the subject matter. The new stakeholder was intent on developing the game further, but had few specific ideas on how to approach it.

#### 3.2 Case 2: When Life Gives You Lemons (WLGYL)

The second case study was developed as part of a MSc graduation project [28]. WLGYL is a 2D role-playing game (RPG) aimed at teaching girls with autism



Fig. 2. Screenshots from the case study prototypes of PCC (left) and WLYYL (right).

about emotions and social skills. The game was designed with input from psychologists and the target audience in multiple co-design sessions. In the game, the player takes the role of a young girl going on a summer camp, where her task is to make new friends. She does so by exploring the camp and talking to other characters. Talking to characters presents the player with narrative scenarios, in which a player needs to make choices. The scenarios encourage the player to explore the effects of choices to learn about different types of social interaction. Each interaction is rewarded with an ‘emotion card’ (e.g., ‘anger’) that provides information on that emotion.

The project was picked up by another group of MSc students to continue development and test it. The existing prototype was not completely functional and had limited content. The new group (advised by the previous developer, their supervisors, and a research group of psychologists) also determined that the initial game’s design was too complex: trying to teach or improve emotion regulation and social skills. They limited the scope of the game to anger coping mechanisms. However, at this point they were facing difficulties managing the input from several sources, and assessing the impact of their design decisions.

### 3.3 The Lens of Attention

The Lens of Attention was applied to both of these cases according to a fixed procedure. First, **the existing design was mapped** in line with a given set of conceptual factors from applied game models (e.g., the learning content [3, 22, 46], the physical space [25], the role of facilitators [3, 25], additional media [12] and infrastructure [23]). The existing game mechanics and systems were similarly identified. The **intended overlap between purpose and game systems was then determined** [25]. The third step was to **evaluate the game systems for how they mediated interaction with the purpose**. This was done by **relating them to the areas of involvement**, to see how they aimed to *capture and hold attention*, offered *variety and balance*, and *directed attention towards the purpose*.

In WLYYL, multiple stakeholders were involved and discussed these aspects with each other. In PCC, with a single stakeholder, the investigator had a



more prominent role. All discussions were collaborative, however – the investigator prompted the stakeholders to consider certain topics and trigger reflection. Visual aids were used in the form of a (physical or digital) whiteboard to which both investigator and stakeholder(s) could add information (Fig. 3). Discussion was kept open for stakeholders to ask questions, amend prompts to suit their needs, or add thoughts and ideas that had not been asked about specifically. Similarly, the investigator could add or adjust questions and topics of discussion when the situation called for it.

### 3.4 Design Discussions

Discussions were held both online and in person, and lasted a total of several hours for each project. The primary investigator of this article held discussions with one or several stakeholders of the applied game project. The stakeholders were first introduced to the lens of attention. Then, this theory was applied to the existing design.

Discussions began with discussing and defining the existing game concepts. The stakeholders determined the games' goals and target audience. This, in turn, led to discussion on metrics of success that could be used to determine whether the game is successful in achieving those goals. Despite both projects having gone through a significant design and development phase, discussion of these topics unearthed several points of confusion or disagreement. In particular, the question of **context** (i.e., play conditions, physical environment, and facilitators) had not been considered before. In both cases, the games were assumed to be standalone products, used by their target audience seemingly 'just because'. In PCC, this raised the question of whether healthcare workers would autonomously decide to put on a VR headset (either at home or in the workplace) to learn about person-centred care, or what would keep them from doing so. A similar discussion took place in WLGYL on the question of whether the game should be used together with a therapist. In these discussions, the point of **time and frequency** came up, that is, how often and how long the game was envisioned to be played. This had not been a point of consideration in either project, yet led to extensive discussion on the design implications of various decisions and how the context could be more meaningfully integrated into the game's design. For example, in PCC the option of integrating the game in existing (non-game) training programs teaching person-centred care was discussed. This type of group setting would make VR a less valid option, unless the functionality to project the player's view onto a screen for a group to follow along was added. In both case studies, the importance of **reflection** was an important element of these discussions as well, and whether the games would benefit from being played over multiple sessions, allowing players to put what they had learned into action and reflect on it. In WLGYL, mechanics such as a character being used to help the player reflect on their past week (in the case of weekly play sessions) were discussed, as well as other mechanics to further trigger moments of introspection by the player.

Part of mapping the original design was to establish where there was overlap between applied purpose and game systems. Both games had a clear



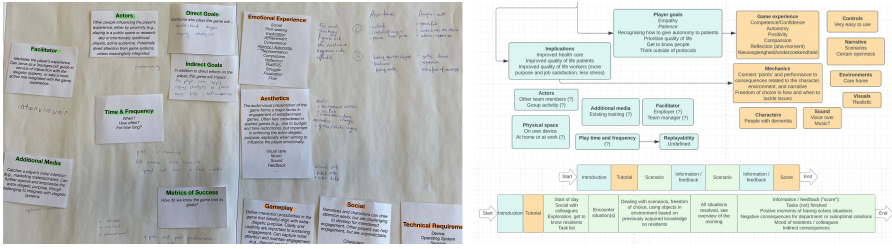


Fig. 3. Work-in-progress of the visual aids used during discussions.

overlap between the purpose and systems within the narrative scenarios - players were exposed to the educational content through the story and characters, and made choices within these sections. The areas of involvement were those of social involvement and, to an extent, gameplay. In the remainder of the design, however, the overlap was very limited.

WLGYL had included moments of exploration to the narrative sections. Although this did not have much overlap with the purpose, it did introduce rhythm into the game structure by switching attention to a different type of gameplay and allowing for moments of ‘down time’. Additions similar to this were discussed in the context of PCC, to bring variety to the experience, as well as to provide players agency to learn about the characters and to make informed choices.

While both games used gameplay and social involvement to some extent, **affective involvement had either been neglected or completely undefined**. Art styles were chosen either for realism (PCC) or to be appealing to the target demographic (WLGYL). WLGYL had some thoughts on the emotions they wanted players to feel (e.g., anger and relief), but had not yet given thought to how to elicit such emotions through their visual design. PCC had not much considered the emotions of the player prior to the discussion, even though the target audience experiences deep and varied emotions when dealing with their clients. In both cases, discussions on affective involvement led to amendments to the original design. For example, WLGYL considered **how the use of the game’s aesthetics could enforce the emotional experience**, by emphasising what characters (including the player) were meant to emote. For example, in addition to informing the player through text, they also considered shrinking the character portrait when they felt uncertain or insecure, or enlarging them using animations and changes in colour to convey anger.

Both games used some form of points as feedback method for the player. PCC provided the player with stars based on how well they performed in a scenario. In WLGYL, in addition to points, the player could collect emotion cards. Although these provide some information, they had no other function in the game. In many applied games, points also serve as a motivator for improvement. In both of the games studied in the context of this article, however, the stakeholders were not happy with the utilitarian approach in the original design. Through discussion,

it became clear that this was, at least in part, due to the sensitive or emotional topics the games address. In this context, it felt too simple and not nuanced enough to judge a player's performance through points. The stakeholders also questioned whether players would experience the intended reflection on their own behaviour on the basis of points as a primary mechanism of feedback. In PCC, it was considered likely that, rather than reflecting on the scenarios and their content, players would simply be motivated to find the 'correct' answer to gain a good score [20].

Discussions around this topic focused on **contextualising the feedback given to the player**. In WLGYL, stakeholders decided to use the emotion cards as a gameplay mechanism, by allowing the player to use previously collected cards and 'put them into practice' in subsequent conversations. This elevated the cards from a form of feedback to an active component in the game's mechanics, allowing for further integration of the purpose. They also considered changes to the game's progress screen, visualising the extended effects of the player's decisions on how skilled they became in different coping strategies and the overall camp atmosphere.

A similar discussion took place for PCC. The consequences of person-centred care go well beyond the 'performance' of the practitioner. Rather than a simple score, decisions by the player in PCC could show the impact on the happiness of people with dementia, as well as the impact on the player character's well-being. On the other hand, spending more time with a client could negatively impact other factors, such as being able to finish other tasks, increasing pressure on colleagues. Incorporating such elements in the feedback would not only make the benefits of practising person-centred care more tangible to the player, they also could inspire reflection beyond the educational information offered by the game, and spark discussion outside the game environment (e.g., about aspects of a department preventing practitioners from working more person-centred, like time and budget). Such ideas were not completely fleshed out within the design discussions, as both the investigator and stakeholder lacked the necessary knowledge on the topic. However, such topics were considered **particularly suitable to discuss in a co-design session with the target audience and other stakeholders**.

## 4 Discussion

Both the case studies described in Sect. 3 started out from a consideration of mechanics, as is in line with many applied game design frameworks. This approach did not result in perfect designs. While this is expected (the first iteration of an idea is rarely the last), it also left the stakeholders unsure how to diagnose the issues and how to continue development. While different issues were diagnosed in both cases, **the lens of attention helped to identify that there was a lack of connection between the different aspects that, together, form a player's experience: gameplay, social and, particularly, affective involvement**.

The lens of attention provided a tool for reflection, that opened the door to new discussion and design ideas. Any decisions resulting from the discussions would need to be tested upon implementation. Doing so was outside the scope of this article. Games are generally developed through an iterative process. The lens of attention could be a recurring tool within applied game development, used to assess the design after each moment of testing to identify new issues and evaluate whether the previous decisions ended up working as intended.

The games discussed in this article are similar in design to other applied games developed for comparable purposes. Based on the experience gained in discussion these projects, the following preliminary guidelines can thus be proposed:

**Consider Context, Including Play Time and Frequency:** Even with care and consideration, it is possible that aspects of a design are not clearly defined or properly considered, or that they are simply overlooked. Of particular importance in the case studies was to consider the games in their larger context, and the potential necessity of designing moments of built-in reflection. Increased understanding of the game's context also served as inspiration for design, and a basis for structuring co-design efforts.

**Map the Overlap:** Mapping the game's intended elements or sections of gameplay helped to visualise where there was a lack of meaningful integration between content and game systems. This exercise in particular helped to identify where perceived issues with the existing design originated from. In the case studies, the lack of overlap was particularly noticeable in the feedback systems. It also made it clear whether and when a game could potentially benefit from (out-of-game) reflection moments, or whether the experience was potentially more monotonous than intended.

**Create Balance Using Affective Involvement:** The consideration of balancing the different areas of involvement flowed naturally from a mapping of the overlap. A varied experience is required to keep players engaged, able and willing to focus on the learning content. This can be done, not only through the areas of gameplay and social involvement, but that of affective involvement as well. It is recommended to search for aspects of a project's design in which that third area of attention in particular can be better utilised.

**Contextualize Feedback and Integrate Context:** One way of increasing the affective experience of a game is to integrate the extended effects of the game's learning content. Feedback mechanisms in particular proved to be underutilised in the case studies, despite their potential in increasing reflection and affective involvement.

Finally, it should be noted that not every applied game *needs* to provide a deeper, emotional experience. Many entertainment games are very successful aiming for simple, singular mechanics (e.g., many mobile games, such as *Candy Crush* [24]). As an extension, many applied games can benefit from similar designs, using simple mechanics, bright colours, and feedback points to motivate further play. However, applied games often tackle subjects that would benefit

from approaching their design from another perspective. It is for those projects, that this article aims to be of use. The theory presented here does not point to one particular solution or is meant as a ‘cook-book’-style approach to game design. Rather, it is **a perspective to be used in conjunction with other methods that should help practitioners and researchers understand the design they are working on**, and give ideas of furthering their design beyond the use of specific mechanics and points to motivate play.

## 5 Conclusion

This article presented the theory of attention, adapting it from how it has been used in commercial game design, and implementing it in existing theory on applied games. The result is the ‘lens of attention’ for applied games, based on the AGEM and other models of applied game design. The article explored practical use of the lens through two case studies, helping stakeholders apply the theory to their applied games and reporting the resulting discussions.

The stakeholders expressed positive views towards the use of the theory, stating that it **provided them with new insights and clarified previously undefined concerns about the existing design, made them consider questions and topics that had not previously occurred to them, and opened up the path to new design decisions.**

Naturally, the narrative presented in this article provides limited validation of the theory. Future efforts in this research direction will focus on formulating a practical ‘how-to’ on the lens of attention, so that it may be applied by more practitioners, developed further, and assessed in different types of situations and in combination with existing design methods.

Applied games find themselves ‘competing’ with a massive variety of entertainment titles that offer unique and engaging player experiences. Some applied goals can be achieved with fairly simple designs, using tried and established base mechanics. In order for applied games to tackle more complex problems, however, it is essential that their design methods evolve with those of their entertainment counterparts. This article provides some insight into how to achieve this, with the hope that practitioners may continue to develop it and continue to advance the practice of applied game design.

## References

1. Bateman, C.: Game writing: Narrative skills for videogames. Bloomsbury Publishing, USA (2021)
2. Bateman, C., Boon, R.: 21st Century Game Design (game development series). Charles River Media, Inc. (2005)
3. Bellotti, F., et al.: Designing serious games for education: from pedagogical principles to game mechanisms. In: Proceedings of the 5th European Conference on Games Based Learning, pp. 26–34. University of Athens Greece (2011)
4. Bogost, I.: Why gamification is bullshit. *Gameful wWrld: Approach. Issues Appli.* **65**, 65–79 (2015)

5. Calleja, G.: *In-game: From immersion to incorporation*. MIT Press (2011)
6. CDProjekt Red: *The Witcher 3: Wild Hunt*. [Nintendo Switch, PlayStation 4, PlayStation 5, Xbox One, Xbox Series X/S, Microsoft Windows] (2015)
7. Chee, C.M., Wong, D.H.T.: Affluent gaming experience could fail gamification in education: a review. *IETE Tech. Rev.* **34**(6), 593–597 (2017)
8. ConcernedApe: *Stardew Valley*. [Microsoft Windows, macOS, Linux, PlayStation 4, Xbox One, Nintendo Switch, PlayStation Vita, iOS, Android] (2016)
9. De Freitas, S., Jarvis, S.: A framework for developing serious games to meet learner needs. In: *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)* (2006)
10. De Freitas, S., Neumann, T.: The use of ‘exploratory learning’ for supporting immersive learning in virtual environments. *Comput. Educ.* **52**(2), 343–352 (2009)
11. Fazio, S., Pace, D., Flinner, J., Kallmyer, B.: The fundamentals of person-centered care for individuals with dementia. *Gerontologist* **58**(suppl.1), S10–S19 (2018)
12. Fisch, S.M.: Making educational computer games “educational”. In: *Proceedings of the 2005 Conference on Interaction Design and Children*, pp. 56–61 (2005)
13. Fisher, A., Kloos, H.: Development of selective sustained attention: The role of executive functions. In: *Executive Function in Preschool-age Children: Integrating Measurement, Neurodevelopment, and Translational Research*, pp. 215–237 (2016)
14. FromSoftware: *Elden Ring*. [Playstation 4, Playstation 5, Microsoft Windows, Xbox One, Xbox Series X/S] (2022)
15. Gómez-Maureira, M.A., Kniestedt, I., Van Duijn, M., Rieffe, C., Plaat, A.: Level design patterns that invoke curiosity-driven exploration: An empirical study across multiple conditions. In: *Proceedings of the ACM on Human-Computer Interaction 5(CHIPLAY)*, pp. 1–32 (2021)
16. Grund, C.K.: How games and game elements facilitate learning and motivation: A literature review. In: *INFORMATIK 2015* (2015)
17. Hamari, J., Koivisto, J., Sarsa, H.: Does gamification work?—a literature review of empirical studies on gamification. In: *2014 47th Hawaii International Conference on System Sciences*, pp. 3025–3034. IEEE (2014)
18. Hew, K.F., Huang, B., Chu, K.W.S., Chiu, D.K.: Engaging asian students through game mechanics: Findings from two experiment studies. *Comput. Educ.* **92**, 221–236 (2016)
19. Hookham, G., Nesbitt, K.: A systematic review of the definition and measurement of engagement in serious games. In: *Proceedings of the Australasian Computer Science Week Multiconference*, pp. 1–10 (2019)
20. Hung, A.C.Y.: A critique and defense of gamification. *J. Interact. Online Learn.* **15**, 57–72 (2017)
21. Karth, I.: *Ergodic agency: how play manifests understanding*. In: *Engaging with Videogames: Play, Theory and Practice*, pp. 205–216. Brill (2014)
22. Kiili, K.: Content creation challenges and flow experience in educational games: The it-emperor case. *Internet High. Educ.* **8**(3), 183–198 (2005)
23. Kiili, K., De Freitas, S., Arnab, S., Lainema, T.: The design principles for flow experience in educational games. *Proc. Comput. Sci.* **15**, 78–91 (2012)
24. King: *Candy Crush Saga*. [iOS, Android, Microsoft Windows Phone, Microsoft Windows, macOS, Linux] (2011)
25. Kniestedt, I., Lefter, I., Lukosch, S., Brazier, F.M.: Re-framing engagement for applied games: A conceptual framework. *Entertain. Comput.* **41**, 100475 (2022). <https://doi.org/10.1016/j.entcom.2021.100475>, <https://www.sciencedirect.com/science/article/pii/S1875952121000720>

26. Lemarchand, R.: Attention, not immersion: Making your games better with psychology and playtesting, the uncharted way (2012). <https://www.gdcvault.com/play/1015464/Attention-Not-Immersion-Making-Your>
27. Lemarchand, R.: *A Playful Production Process: For Game Designers (and Everyone)*. MIT Press (2021)
28. Libbi, C.: When life gives you lemons: designing a game with and for autistic girls, Aug 2021. <http://essay.utwente.nl/88356/>
29. Malliarakis, C., Satratzemi, M., Xinogalos, S.: Designing educational games for computer programming: A holistic framework. *Electr. J. of e-Learn.* **12**(3), 281–298 (2014)
30. Naughty Dog: *Uncharted 3: Drake’s Deception*. [Playstation 3] (2011)
31. Nintendo EAD: *Animal Crossing*. [Nintendo 64, Nintendo Gamecube] (2001)
32. Nintendo EAD: *The Legend of Zelda: Breath of the Wild*. [Nintendo Switch, Nintendo Wii U] (2017)
33. O’Donnell, B.F.: Forms of attention and attentional disorders. In: *Seminars in Speech and Language*, vol. 23, pp. 099–106 (2002)
34. Orland, K.: Putting elden ring’s 12 million sales in context (2012). <https://arstechnica.com/gaming/2022/03/putting-elden-rings-12-million-sales-in-context/>
35. Parnandi, A., Gutierrez-Osuna, R.: A comparative study of game mechanics and control laws for an adaptive physiological game. *J. Multimodal User Interfaces* **9**(1), 31–42 (2015)
36. Camps-Ortueta, I., González-Calero, P.A., Quiroga, M.A., Gómez-Martín, P.P.: Measuring preferences in game mechanics: Towards personalized chocolate-covered broccoli. In: van der Spek, E., Göbel, S., Do, E.Y.-L., Clua, E., Baalsrud Hauge, J. (eds.) *ICEC-JCSG 2019*. LNCS, vol. 11863, pp. 15–27. Springer, Cham (2019). [https://doi.org/10.1007/978-3-030-34644-7\\_2](https://doi.org/10.1007/978-3-030-34644-7_2)
37. Schell, J.: *The Art of Game Design: A book of lenses*. CRC Press (2008)
38. Sicart, M.: Defining game mechanics. *Game Stud.* **8**(2) (2008)
39. Strickland, D.: *Witcher 3’s ‘40 second rule’ kept players engaged* (2017). <https://www.tweaktown.com/news/59420/witcher-3s-40-second-rule-kept-players-engaged/>
40. Styles, E.: *The psychology of attention*. Psychology Press (2006)
41. Sweetser, P., Wyeth, P.: Gameflow: a model for evaluating player enjoyment in games. *Comput. Entertain. (CIE)* **3**(3), 3–3 (2005)
42. Thatgamecompany: *Flow*. [Playstation 3, Playstation 4] (2006)
43. Thatgamecompany: *Flower*. [Playstation 3, Playstation 4, iOS, Microsoft Windows] (2009)
44. Tsita, C., Satratzemi, M.: Conceptual factors for the design of serious games. In: Gentile, M., Allegra, M., Söbke, H. (eds.) *GALA 2018*. LNCS, vol. 11385, pp. 232–241. Springer, Cham (2019). [https://doi.org/10.1007/978-3-030-11548-7\\_22](https://doi.org/10.1007/978-3-030-11548-7_22)
45. *Ustwo: Monument Valley*. [Android, iOS, Microsoft Windows, Microsoft Windows Phone] (2014)
46. Yusoff, A., Crowder, R., Gilbert, L., Wills, G.: A conceptual framework for serious games. In: *2009 Ninth IEEE International Conference on Advanced Learning Technologies*, pp. 21–23. IEEE (2009)