Player Experience

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Josef Wiemeyer, Lennart Nacke, Christiane Moser
and Florian 'Floyd' Mueller

Abstract

In computer science, the concept of user experience has proven to be beneficial in order to improve the quality of interaction between software and its users, by taking users' emotions and attitudes into account. In general, user experience focuses on interaction. As not only interaction (e.g., good usability) is of importance for players, this chapter discusses how the concept of user experience can not only be applied to serious games, but also how it can be extended in order to cover the characteristics of games as a special software. For this refined concept, the term *player experience* has been coined. First, the concept of player experience is introduced in this chapter. The adequate conceptualization of player experience requires differentiating specific dimensions like (game-) flow, immersion, challenge, tension, competence, and emotions. Because of the individual nature of player experience, psychological models need to be used for the conceptualization as they are able to reflect this multidimensional structure. In addition, interdisciplinary models are needed in order to address the various factors influencing player experience. This ensures a holistic approach. Second, the question how to measure player experience is discussed. Here, different levels

J. Wiemeyer (✉)
Technische Universität Darmstadt, Darmstadt, Germany
e-mail: wiemeyer@sport.tu-darmstadt.de

L. Nacke
University of Waterloo, Waterloo, Canada

C. Moser
University of Salzburg, Salzburg, Austria

F. 'Floyd' Mueller
RMIT University, Melbourne, Australia

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have to be distinguished: Behavior, physiological reactions, and subjective experience. Finally, it is shown how knowledge about player experience can be employed to develop serious games systematically and to improve their quality.

9.1 Introduction

According to their double mission characterized in Chap. 1, serious games have to accomplish at least two goals: on the one hand entertainment and on the other hand the characterizing goal(s). The entertainment goal will be addressed in this chapter, whereas Chap. 10 will deal with the characterizing goal(s). Experiencing a serious game as a “game” is a personal and individual matter. According to Huizinga (2013), playing games has a different meaning in different cultures. In Chap. 1, gaming or ludus (rule-based) has been distinguished from playing or paidea (free). The individual and personal experience of gaming comprises numerous aspects, for example, intrinsically motivated actions (free of external determination), performing symbolic or fictional actions in a quasi-real context constrained by the rules of a game, ambivalence and openness to both procedure and outcomes, presence and immersion etc. All these aspects refer primarily to the (socio-)psychological experience of the players. Therefore, (socio-)psychological factors play an important role in the research on player experience. On the other hand, personal experience is accompanied by more or less specific observable behavior (like laughing, smiling or frown) and physiological reactions (like increased heart rate or blood pressure). Accordingly, three levels of player experience need to be distinguished:

- The (socio-)psychological level (individual experience)
- The behavioral level
- The physiological level

Because the individual (socio-)psychological level is the constituent aspect of player experience this aspect will be emphasized in this chapter.

The uniqueness of gaming experience is one important reason for the great success of digital games in general. The goal of serious games is to exploit this fascination of players to enhance engagement, in order to foster the acquisition of the characterizing goal(s). Therefore, it is important to know how player experience is structured to systematically address mechanisms that elicit player experience. In a strict sense, *player experience* is the more appropriate term as compared to *game experience,* because it is the person of the player who makes this specific experience. Therefore, player experience (PE) will be used in this chapter whenever possible. Player experience has to be distinguished from player types. Whereas the former denotes a transient and dynamic construct (state), the latter denotes a more or less stable and static construct or trait. For a recent approach to player types, see (Nacke et al. 2014).

This chapter is divided into four main parts. First, the concept of user experience will be discussed as a kind of precursor of player experience. Second, psychological models of player experience are discussed to clarify the mechanisms and components of player experience. Third, integrative models of player experience are addressed. These models integrate the findings of numerous scientific disciplines, e.g., (neuro-) physiology, psychology, and sociology to explain the factors contributing to player experience. Often, these models are dedicated to a specific domain, e.g., exergames or educational games. In the last part of this chapter, guidelines and recommendations are given to foster player experience.

9.2 User Experience as a Precursor of Player Experience

In the past decade, we have seen a surge of interest in the emotional and affective aspect of user experience (UX), especially in entertainment media, such as video games. Before it became a field of its own, games user research (GUR) was often done informally within the development team or with players that were close friends of the developers. Today, GUR is a formal process with its own set of techniques that is aimed at finding the desired experience for a game together with the design team. Classic usability testing is not sufficient for testing games, since its standard metrics, such as effectiveness measured as task completion or efficiency measured as error rates, do not map directly to evaluating games. Developers of user interfaces for desktop software are primarily concerned with functionality, while games need to be evaluated with a strong focus on the human aspect—the player—in mind. Traditional usability metrics remain relevant in GUR, but they are subsidiary means that can supplement other forms of evaluation of digital games.

User experience is a concept that has been misunderstood for years, because the shift of research from a focus on functionality toward creating an aesthetically pleasing experience was done slowly. Similarly, we have seen quality assurance and simple functionality tests in game development for years, but during the past decade, the choice toward creating entire games user research departments became obvious for many game developers. The focus on humans as part of evaluating technology is now the de facto standard for many evaluation approaches within human-computer interaction (HCI) and has led to prominence of user experience (UX) research over usability research. For video games, understanding and attempting to measure player experiences (PE) has become a core aspect of GUR. Thereby, PE describes the qualities of the player-game interactions and is typically investigated during and after the interaction with games (Nacke et al. 2009).

Along these lines, it might be useful to distinguish between different GUR concepts, such as playability, game usability, and player experience. There are even more definitions in the literature that refer to different types of player experiences. However, for the sake of our understanding of PE in games, we can distinguish between different levels of perception of gameplay for players. Nacke (2010) introduced a core understanding of these perceived layers of experience within video games. Evaluating the technology is fundamentally different from evaluating the higher level concepts of experience for players within a given context (Engl and Nacke 2013). The ideas behind playability and game usability seem to be more relevant for ensuring a good experience for players on a technological level, which serves as the foundation for creating good player experiences subsequently.

Whereas *playability* and *game usability* refer to the technological level, *player experience* denotes the individual and personal experience of playing games. Player experience describes the qualities of the player-game interactions and is typically investigated during and after the interaction with games.

Analogous to HCI, where a shift took place from *usability* to *user experience (UX)*, in games research *player experience (PE)* has gained importance rather than *game experience (GX)*.

In the related literature, we find a number of different understandings regarding PE in games. By reviewing these, we can move toward a better definition of PE in games.

Brown and Cairns (2004) have noted that players choose games they play according to their mood, and it is to be expected that people especially seek games that elicit appreciated emotional responses. Therefore, it is necessary to get to know the player better (e.g., how they play, what motivates them to play, or what creates aversion towards certain game forms; Mäyrä 2008a, b). Ravaja et al. (2008) evaluated emotional response (e.g., emotional valence, arousal, and discrete emotions like joy, pleasant relaxation, anger, fear, and depressed feelings) and sense of presence as potential criteria in games from the point of view of UX.

Gerling et al. (2011) state that the term player experience "in video games describes the individual perception of the interaction process between player and game," and is derived from the phenomenon of UX (defined in ISO 9241-210:2010) describing how a person perceives and responds to the interaction with a system—both highlighting the subjective, psychological nature of the phenomenon and focusing on the interaction process.

Lazzaro (2008) argues that UX and PE are not the same. For her, UX is the experience of use (i.e., how easily and well suited is the system to the task or what the person expects to accomplish in order to advancing the usability), while PE is the experience of play (i.e., how well the game supports and provides the type of fun the player wants to have). She claims that UX looks at what prevents the ability to play, and PE looks at what prevents the player from having fun.

Nacke and Drachen (2011) introduce a framework to investigate player experience based on existing UX research and the differences between games and other applications. For them, PE is related to the user experience in the context of digital games. They claim that current PE research is aimed at investigating emotional, social, and cognitive components of the experience emerging from the interaction between players and a game. In contrast to most UX research, they also want to take into account PE before, during and after interacting with a game (inspired by Law et al. 2007). Schell (2008) noted that games enable PE through interaction with game elements and/or other players, but the imagined (i.e., anticipated) player experience is the reason for people to play.

Many of these papers use definitions of player, gameplay, gaming, playing, or player experiences without establishing what such a construct would actually mean. The most useful for a shared understanding of PE is, therefore, to think about how these terms can provide a useful vocabulary for GUR when trying to improve video game design. This remains challenging as new models of PE are being developed and tested.

Furthermore, the concept of PE is divided to reflect specific aspects of play, such as challenge, tension or anxiety, and immersion within the game world. Immersion is of particular interest when discussing novel interactive technologies and control paradigms, as designers strive to enhance realism and meaningful interaction within games. The integration of new technologies can have a multitude of differing impacts on PE, affecting the ability of players to understand their role in the game world and to effectively complete game objectives. Ultimately, the effects of any one system element on the entire player experience is composed of an intricate collection of relationships between the factors defining PE. For a better understanding of these elements, we have to turn to psychological models of human motivation and behavior to create a holistic picture of PE.

9.3 Psychological Models of Player Experience

In principle, the experience of gaming is a personal experience. Therefore, psychological models try to explain the structure of player experience as well as the factors contributing to this experience. In this section, models that address player (or game) experience are discussed. Unfortunately, as has been argued in the previous section, there is no general agreement on player experience. Therefore, various models are introduced and discussed first. In a next step, the components and factors addressed by the models are summarized.

Psychological models can be divided into two categories: *Generic models* that have been developed for a wide range of application areas including gaming, and *domain-specific models* that have been developed especially for the game domain. Generic models range from simple behaviorist frameworks (like instrumental conditioning by Skinner) over cognitivist or information processing approaches to constructivist approaches. Due to limited space, this section will not be able to cover all psychological models that are relevant to understanding and explaining player experience. Rather, selected approaches are analyzed that attempt to explain the particular appeal of player experience.

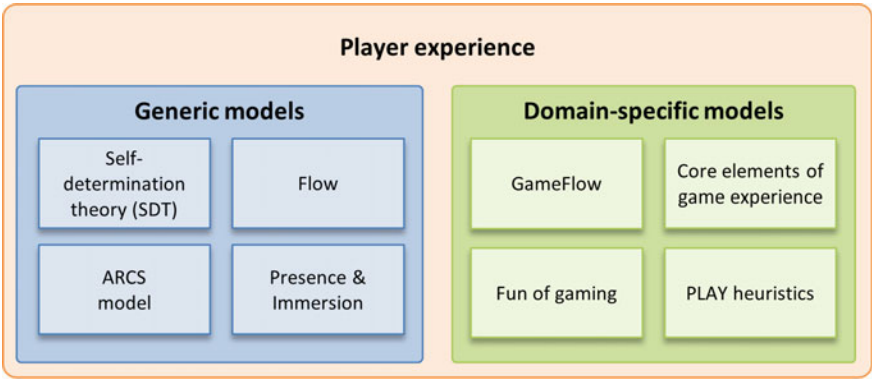

Fig. 9.1 Models relevant to player experience

The following models will be discussed (see Fig. 9.1):

- Self-determination theory (SDT)
- Attention, relevance, confidence, satisfaction (ARCS)
- Flow
- GameFlow
- Presence and immersion
- Fun of gaming (FUGA)
- Core elements of game experience (CEGE)
- PLAY heuristics

Self-determination Theory (SDT)

Player experience is a positive experience including intrinsic motivation. There are numerous models that try to explain how intrinsic motivation arises. One very influential approach is the theory of self-determination (SDT) proposed by Ryan and Deci (2000). According to SDT people have three basic needs: competence, autonomy and relatedness.

The concept of *competence* means that people like to feel being able to meet the requirements of tasks they have to or want to complete. However, it is important to attribute the outcome to one's own engagement or talent. This perceived internal "locus of causality" (Ryan and Deci 2000, p.70) confirms intrinsic motivation as opposed to external attributions, e.g., to chance or support by others. One important source of intrinsic motivation is intrinsic rewards like success. On the other hand, intrinsic motivation can be undermined by all forms of extrinsic reward (for a taxonomy of rewards see Phillips et al. 2013), like money or praise (e.g., Deci et al. 1999).

Furthermore, people want to feel *autonomous* in selecting their individual goals, choosing the means to reach these goals, and evaluating the causes of success or failure. External control is detrimental to intrinsic motivation, for example, resulting in decreased engagement and curiosity.

Beyond competence and autonomy, a third aspect is important for intrinsic motivation, i.e., *relatedness*. Being integrated in various interpersonal settings like parent-child, inter-sibling, or peer-to-peer seems to establish a sense of security to start and maintain exploratory behavior.

For player experience, this means that playing games should support competence (i.e., by appropriate level design and feedback), autonomy (i.e., by experiencing internal control of gaming), and relatedness (i.e., by establishing a game community for communication and collaboration).

Ryan et al. (2006; see also Rigby and Ryan 2007) extended the SDT to the *Player Experience of Need Satisfaction* (PENS) model. The PENS approach includes five dimensions:

- *PENS in-game autonomy*: This dimension denotes the experience of the players to feel free to make decisions and choices in the game.
- *PENS in-game competence*: This dimension concerns an appropriate balance between the challenges of the game and the competence level of the players.
- *PENS in-game relatedness*: In-game relatedness means, how much the players are feeling connected to other players in the game.
- *PENS presence*: This dimension is subdivided into three subdimensions, i.e., physical, emotional, and narrative presence.
- *PENS intuitive controls*: This dimension concerns the ease of control in the game, e.g., by easy-to-remember control keys.

Attention, Relevance, Confidence, Satisfaction (ARCS)

Keller (1987, 2009) developed a model that includes four main strategies to elicit and maintain motivation: Attention, relevance, confidence, and satisfaction (ARCS).

Attending to information is a widely accepted prerequisite of information processing. Information that is not in the focus of attention goes unrecognized and will not be processed. Attention plays a role in many models of human behavior. There seems to be an optimum of attention. This implies that an appropriate balance has to be established on the continuum of extremely low and extremely high attention. Possible means to attract attention in a game are a surprising event, a loud noise, or a quiet pause.

Relevance means that the activity should be considered purposeful and meaningful from the perspective of the player. Therefore, the player should be able to immediately recognize the functional significance of every in-game activity.

Confidence or expectancy of success means that the players have the persuasion to be successful if they show sufficient engagement. The level of confidence has important consequences for several aspects—for example, causal attribution in case of success (ability and effort rather than good luck), increased and sustained engagement, and self-efficacy.

Satisfaction means that people “feel good about their accomplishments” (Keller 1987, p.6). Analogous to intrinsic motivation mentioned in the previous subsection, intrinsic satisfaction and personal enjoyment can decrease if the activities are externally controlled.

Flow

Flow is a particular state that emerges when people perform intrinsically motivated or *autotelic* activities, i.e., activities bearing their rewards in themselves (see also Chap. 1). The state of flow has the following characteristics (Nakamura and Csikszentmihalyi 2002): Increased and focused attention on the current activity, merging of action and awareness, loss of reflective self-consciousness, sense of control over one’s actions, distortion of time experience, and experience of the activity as intrinsically rewarding.

According to Jackson and Marsh (1996), the flow experience has the following nine dimensions: Balance of challenge and skill level, merging of action and awareness (i.e., things happen automatically), clearly defined goals, unambiguous, i.e., clear and immediate, feedback, concentration on task at hand, sense of control, loss of self-consciousness, transformation of time, and autotelic experience. The authors could confirm this nine-scale structure by a confirmatory factor analysis.

GameFlow

Sweetser and Wyeth (2005) applied the concept of flow to gaming in order to explain enjoyment in games. Their concept of *GameFlow* consists of eight elements: concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. Table 9.1 maps the elements of GameFlow proposed by Sweetser and Wyeth (2005) to the elements of Flow proposed by Jackson and Marsh (1996).

Furthermore, the authors deliver numerous criteria to assess the eight elements of GameFlow. For example, concerning the control dimension players should feel a sense of control over the actions of their characters, their interfaces, the game shell (i.e., starting, stopping, saving), and their strategies.

Presence and Immersion

Presence is a concept that has a close relationship to flow experience on the one hand and to immersion on the other hand. People experiencing presence in media-controlled environments like virtual reality or digital games have the feeling of “being there,” i.e., actually being in the scene regardless of the notion that the scene is artificial. Whereas *presence* denotes a specific personal experience, *immersion* is suggested as an umbrella term by Nacke (2009a, b) which incorporates presence and flow as certain stages. There are several connotations of presence (Lombard and Ditton 1997), and the concept is considered a multi-faceted phenomenon. A common distinction is made between social and physical (i.e., spatial) presence (Schultze 2010).

Table 9.1 Mapping elements of GameFlow (Sweetser and Wyeth 2005) to elements of flow (Jackson and Marsh 1996)

GameFlow element (Sweets and Wyeth 2005)	Flow element (Jackson and Marsh 1996)
Concentration	Concentration on task at hand
Challenge	Balance of challenge and skill level
Skills	
Control	Sense of control
Clear Goals	Clearly defined goals
Feedback	Unambiguous, i.e., clear and immediate, feedback
Immersion	Loss of self-consciousness
	Transformation of time
Social Interaction	–
–	Autotelic experience
–	Merging of action and awareness

According to the process model of spatial presence proposed by Wirth et al. (2007), spatial presence evolves according to two consecutive stages. First, a spatial situation model is established depending on attentional processes, which are influenced by both media and user factors. Second, a spatial presence experience emerges depending on involvement and suspension of disbelief. The authors developed and validated an eight-scale spatial presence questionnaire (Wirth et al. 2008).

Takatalo et al. (2011) try to integrate presence and flow. In their *Presence-Involvement-Flow Framework (PIFF^2)*, they state that on the one hand presence and involvement in a game are influenced by the (interactive) way the player establishes a relationship with the game (adaptation); on the other hand, the level of flow influences the cognitive evaluation and the emotional outcomes of playing.

Furthermore, the authors distinguish ten subcomponents of player experience: Skill and competence, challenge, emotions, control, autonomy and freedom, focus and concentration, physical presence, involvement, meaning and curiosity, story, drama and fantasy, social interaction and interactivity, controls, and usability.

Fun of Gaming (FUGA)

Based on focus groups, expert interviews and questionnaire studies, Poels et al. (2008) developed a seven-factor model of player experience. The seven factors are specified as follows: Sensory and imaginative immersion, tension, competence, flow, negative affect, positive affect, and challenge. Note that the presence dimension was subsumed under the immersion dimension. Negative and positive affects denote unpleasant and pleasant emotional responses, respectively.

Core Elements of the Gaming Experience (CEGE)

Calvillo-Gámez et al. (2010) proposed a "theory of the Core Elements of the Gaming Experience (CEGE)." This model was developed using qualitative methods. It identifies two essential factors influencing the experiences of immersion, flow and presence when playing digital games: puppetry and video-game perception.

The term *puppetry* denotes the player's interaction with the game. This interaction is shaped by the player's *sense of control*, e.g., operating controllers and memory load, and *ownership*, e.g., personal goals, actions, and rewards. Furthermore, facilitators like aesthetics, previous experience, and playing time moderate the interaction process.

The term *video-game (perception)* denotes how the player experiences the game depending on the environment, i.e., graphics and sound, and game-play, i.e., rules and scenarios.

Using an unconventional terminology, this approach includes many concepts from the above-mentioned generic models like competence.

PLAY Heuristics

Desurvire and Wiberg (2009) proposed a framework for evaluating the playability of games. The framework consists of three categories: Gameplay, coolness/entertainment/humor/emotional immersion, and usability and game mechanics. Many of the 116 proposed heuristics directly address aspects of player experience: Enduring play, challenge, immersion, sense of control, and positive emotions.

Combining the Results

The approaches discussed in this section address the process of player experience from different perspectives. One type of model transfers the concepts in general psychology to games. Another type of model starts from the perspective of either the players themselves, or the perspective of game developers and researchers. To combine the results, the following (social-)psychological elements of player experience are reported:

- Competence
- Autonomy and control
- Immersion, (spatial and social) presence, flow, and GameFlow
- Involvement and (enduring) engagement
- Social relatedness and social interaction
- Challenge
- Tension
- Curiosity
- Fantasy
- Positive and negative emotions
- Intrinsic goals
- Feedback and evaluation

However, it has also become clear that some of the elements are hardly separable. Furthermore, the approaches state that there are complex interactions between the elements of player experience. In addition, the particular elements themselves are often structured into different components, e.g., flow and presence. Finally, there are numerous moderators influencing the interactions.

9.4 Integrative Models of Player Experience

In this chapter, the multidimensional nature of player experience has been emphasized several times. Therefore, purely psychological model are not able to cover all aspects of this multi-faceted construct. Rather, models integrating the various disciplinary aspects are required, e.g., psychological, sociological, physiological, and biomechanical perspectives (see Fig. 9.2). Due to the double mission of serious games and the domain-specific interrelations of influencing factors in specific application fields, there is a need for the adaptation of generic models (for an example in the field of exergames for persons with disablities, see Wiemeyer et al. 2015).

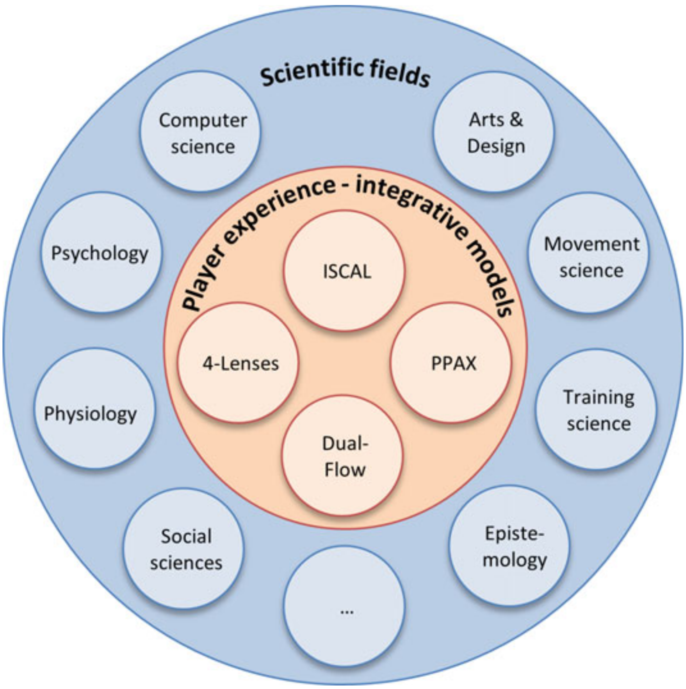

Fig. 9.2 Integrative models of player experience

In this section, selected integrative models are discussed. The following models will be addressed:

- ISCAL model
- Dual-flow model (DFM)
- Four-lens model (4LM)
- Play Patterns And eXperience (PPAX) framework

In a strict sense, these models are not pure models of player experience. However, they address specific features of serious games design that are deemed important for player experience.

ISCAL Model

Zhang et al. (2011) proposed a model for the design of exergames. This model claims that five characteristics are important to establish high-quality exergames:

- Immersion
- Scientificalness
- Competitiveness
- Adaptibility
- Learning

According to the ISCAL model, immersion can be supported by the use of sensor-based feedback, e.g., force, acceleration or movement trajectories, and by naturally mapped interfaces. Concerning natural mapping of interfaces, Skalski et al. (2011) differentiate four types: Directional, kinesic, incomplete tangible and realistic tangible natural mapping. An example of *directional mapping* is the assignment of up movements to a button located at the top of a keyboard or gamepad, and down movements to a button placed at the bottom. An example of *kinesic mapping* is the Sony EyeToy system or the Kinect camera, where gestures without realistic devices have to be performed to indicate one's actions. An example of *incomplete tangible mapping* is the Nintendo Wii remote controller, which may at least partly simulate the feeling of a real object. Using a steering wheel, throttle, and brake pedals for car racing is an example of *realistic tangible mapping*.

Scientificalness of serious games means that the game design has to follow the current state-of-the-art in science. For exergames, this implies that depending on the objective and target group, the relevant theories of motor learning, training, health science, or rehabilitation have to be considered in the game development process. For example, Hardy et al. (2015) proposed a framework for personalized and adaptive health games based on the principles of training science. An example of scientific substantiation of motor learning can be found in Wiemeyer and Hardy (2013). Furthermore, the psychological models of player experience mentioned in the previous section should also be considered.

Competitiveness means that serious games should include comparison to others, either real players or virtual non-playing characters (NPC). However, competitiveness has its limits. Results in several fields show that competition in serious games is not always the best way to enhance player experience. Often, cooperation is a better way to motivate players—for example, in the fields of learning and rehabilitation (e.g., Hattie 2009; Marker and Staiano 2015).

Adaptibility means that the game must be able to perform dynamic adjustments to the more or less static as well as dynamic characteristics of the player. A serious game that does not adapt may lead to a decline of player experience due to overload or underchallenge. Examples for adaptive systems are proposed by Hocine et al. (2014) for motor rehabilitation and by Hoffmann et al. (2014) for individualized aerobic training. This aspect will also be addressed in Chap. 10.

Learning about the environments of serious games is also a feature which may add to the attractiveness of games. Zhang et al. (2011), for example, included learning of knowledge about Chinese and Olympic culture in their function and design framework of a digital Olympic museum. However, knowledge to be learned should always be relevant to the context of the serious games to avoid demotivation due to externally enforced learning of irrelevant information. At the very least, game developers have to consider whether players may actually be interested in the learning subject.

Zhang et al. (2011) applied the model to an exergame for aerobic training. A sample of 20 players (undergraduate students; age: 17 to 22 years; gender: 7 females, 13 males) played this exergame for 15 consecutive days. The ISCAL model was able to differentiate between different playing modes (tour, training, and competition). Furthermore, the study revealed a high level of player experience, i.e., the score was always about 7.5 on a 10-point scale. However, PE was assessed by asking just one question (scale: 1–10). Interestingly, the female player experience initially increased logarithmically, followed by a plateau and small decline, whereas the male player experience started at a high level followed by a gradual decrease. In contrast to this, subjective satisfaction with training effects showed a logarithmical increase in females and males.

Dual Flow Model (DFM)

To address the double mission of serious games, Sinclair (2011) proposed a dual-flow model (DFM). This model differentiates two main objectives: Attractiveness and effectiveness of serious games.

The *effectiveness* of serious games means that the characterizing goal is actually achieved. This requires that serious games are based on sound scientific ground. In exergames, for example, the appropriate load parameters like intensity, duration, density, volume, and frequency have to be considered—as well as the principles of progression, adaptation, and individualization. To ensure optimal effectiveness the load parameters have to be adapted to the physical or psychic capacity of the player. Effectiveness will be impaired if the load imposed by the game leaves the "corridor" of optimal matching. If load is too high, maladaptations and overload will result; if load is too low, no or sub-optimal adaptations will be the consequence.

Attractiveness means that the "system needs to make people want to play the game or games, in order to motivate the user to exercise" (Sinclair 2011, p.38). Following the findings of Malone (1980, 1982), Sinclair claims that attractiveness is supported predominantly by challenge, curiosity, and fantasy. However, the appropriate balance of challenge, curiosity, and fantasy seems to be dependent on the individual characteristics of the player. Furthermore, Sinclair includes the concepts of flow and GameFlow mentioned above, as well as the individual zones of optimal functioning model (IZOF; Hanin 2007) and the *Yerkes-Dodson law* (Yerkes and Dodson 1908). Whereas the flow and GameFlow model relate skill level to challenge, the other two models relate emotions and arousal to performance. In this context, it should be noted that in their original work Yerkes and Dodson already identified task difficulty as a moderator of the arousal-performance relationship. Their experiments indicated that the more difficult the task is the lower is the stress level yielding peak performance. This result is often neglected when referring to the Yerkes-Dodson law as a general inverted-U-shaped relation of stress or arousal and performance. To ensure the attractiveness of serious games, Sinclair (2011) also calls for efficient dynamic difficulty adjustment in order to keep the players in the zone of flow and optimal functioning.

Sinclair (2011) tested his dual-flow model by manipulating the control of intensity (effectiveness) and challenge (attractiveness) on a sample of 21 subjects (age: 21 to 41 years; gender: 8 males, 13 females). Using a repeated-measures design, the subjects played a bike-based exergame under four conditions: Dynamic challenge control and dynamic intensity control, dynamic challenge control only, dynamic intensity control only, and no dynamic control at all. Concerning player engagement assessed by three questions (interest, time perception), the control of intensity evoked a lower level of engagement, whereas there was no differential effect of challenge control. On the one hand, this result illustrates the interrelation of load and attractiveness; on the other hand, the dual-flow model has to be reworked concerning control of challenge.

Four-Lens Model (4LM)

Mueller et al. (2011) proposed a four-lens model of exergames design. Although the model has been particularly developed for exergames, it can easily be transferred to serious games in general. In this model, they distinguish four levels of players' reaction to exergames:

- The responding body
- The moving body
- The sensing body
- The relating body

The *responding body* denotes changes of internal states as a consequence of playing games. Strictly speaking, every system of the human body responds to playing games: Central nervous system, cardiovascular, respiratory, endocrine (hormone), metabolic, neuro-muscular, etc. Therefore, the body's physiological and biochemical responses can be measured to estimate the psychophysical strain or the impact of serious games on player experience. This aspect will be addressed in Sect. 9.5. The responses of the body can be more or less transient (functional adaptations) or permanent (structural adaptations).

The *moving body* means that game (inter)actions are always accompanied by spatio-temporal changes of the whole body or at least of body parts (e.g., fingers). These changes can be quantified by biomechanical sensors. Therefore, trajectories, translational velocity, acceleration, angular displacement, velocity, and acceleration as well as forces, torques, work, and energy can be determined to quantify movements. Biomechanical signals can be used to identify either distinct types of actions, e.g., a backhand stroke in tennis, or action parameters, e.g., force, timing, and direction of a stroke. To support the player experience, sensor signals should be mapped naturally to the game (e.g., Skalski et al. 2011); there should also be a close temporal relationship of player actions and game reactions (feedback) (e.g., Spelmezan 2012). Beyond quantitative characteristics of movement, there are also qualitative aspects like rhythm, speed, fluency, or structure. These features can also be used to control games.

The *sensing body* describes information processing of the players. When playing games, players perceive, make decisions, and solve problems. The game environment, including real or virtual objects, considerably influences these subjective experiences. Therefore, experiences can be more or less realistic or virtual. Both variants bear specific advantages and disadvantages. For example, interacting with virtual environments offers much more degrees of freedom compared to realistic environments. On the other hand, virtual environments may lack the persuasive power of realism—and may even lead to discomfort when signals from different senses do not match. In virtual environments, the phenomenon of "simulator sickness" is well known (e.g., Kolasinski 1995).

The *relating body* means that players interact with, or communicate to, other players. These interactions and communications are mediated by game technology. Mueller et al. (2011) emphasize the fact that social interactions are extremely diverse. Different roles as well as modes of interaction (e.g., cooperation versus competition) determine player experience. Maier et al. (2014) report preliminary results regarding the influence of social relations on gaming. They could find a tendency that social gaming enhanced engagement and motivation to play a rehab game. Furthermore, social relations are a strong factor determining adherence to activities, e.g., gaming or health-related behavior.

Play Patterns And eXperience (PPAX) Framework

The PPAX framework was developed by Cowley et al. (2013) to connect player experience to game design and game context. The model relies predominantly on physiological measures of player experience. This data is the ingredient for computational analysis of higher level relationships. The hierarchical model distinguishes four basic links within a hierarchic framework: Game-player links, design-pattern–personality links, play pattern-reaction pattern links, and game event–play reaction links.

Concerning the personality of the player, general and domain-specific states and traits are distinguished. Furthermore, the model does not only consider single links of game events and play reactions, but also patterns of play-reaction links.

Integrative Models—Summary

To conclude, the integrative models described in this section extend the view on player experience by adding important perspectives, e.g., social and (neuro-) physiological aspects. This knowledge contributes to the quality of serious games design. In particular, the relationship between different disciplinary perspectives has to be considered. Therefore, the development of serious games requires interdisciplinary teamwork. Considering the multi-faceted and interdisciplinary nature of player experience, the question arises as to how the different components and dimensions can be assessed. This issue will be addressed in the following section.

9.5 Measuring Player Experience

Comprehending the interactive relationship that exists between human beings and game systems is a complex and challenging area of ongoing games research within HCI. To obtain an accurate understanding of PE, a plethora of factors must be considered relating to psychological characteristics, gameplay performance, and human emotion. The measurement of these factors is achieved through the use of a number of experimental techniques involving behavioral (e.g., reaction time, and game logs), physiological (e.g., sensors monitoring heart rate, muscle activity, and brain waves) and subjective (e.g., questionnaires and interviews) methods.

Game researchers are thus tasked with the experimental analysis of large groups of interrelating experience factors, often through the manipulation of discrete characteristics of the game system (such as difficulty, control scheme, and sensory feedback) or the context in which the game is played (for a comparison of laboratory and home, see Takatalo et al. 2011). Through the careful manipulation of these variables, researchers attempt to quantify the specific effects of any given change or design decision in a game system. There are several methods that are commonly used in games user research to assess player experiences.

Some of the methods used to access individual player experience are (Nacke et al. 2010a, b; see also Fig. 9.3):

- *Psychophysiological player testing*: Controlled measures of gameplay experience with the use of physical sensors to assess user reactions.
- *Eye tracking*: Measurement of eye fixation and attention focus to infer details of cognitive and attentional processes.

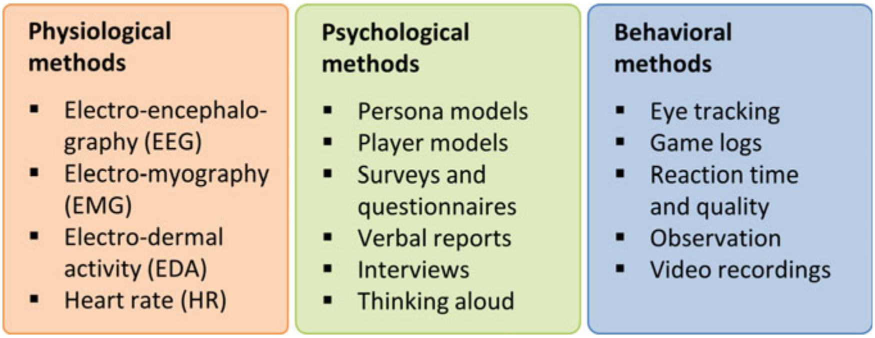

Fig. 9.3 Selected methods for the assessment of player experience

- *Persona modelling*: Constructed player models.
- *Game metrics behavior assessment*: Logging of every action the player takes while playing, for future analysis.
- *Player modeling*: AI-based models that react to player behavior and adapt the player experience accordingly.
- *Qualitative interviews and questionnaires*: Surveys to assess the player's perception of various gameplay experience dimensions.

In this section, we focus primarily on some of the most common evaluation techniques of physiological evaluation and player surveys. For more detailed introductions to measuring player experience with physiological sensors, see Nacke (2013, 2015).

9.5.1 Physiological Evaluation

In pursuit of increasingly complex and fulfilling player experiences, researchers and designers have collaborated to create games that are capable of interfacing with human physiology on an intuitively responsive level. Specifically, evaluation and interaction frameworks are being investigated that enable direct communication between computer systems and human physiology. Beyond the traditional application of such technologies in the medical field, games researchers are finding that the advanced technologies underlying these systems can be leveraged to create player experiences that are more meaningful.

The measurement of physiological activity that is used for evaluating these games is based mainly on sensors that are placed on the surface on the human skin to make inferences about players' cognitive or emotional states.

Most emotion theories distinguish between two basic concepts: Discrete states of emotion (often referred to as basic emotions like surprise, fear, anger, disgust, sadness, and happiness) or biphasic emotional dimensions (arousal and valence, but the dimensions often differentiate between positive and negative, appetitive and aversive, or pleasant and unpleasant). For the physiological player experience evaluation studies that are common in serious games, psychophysiological emotions have to be understood as connected physiological and psychological affective processes. An emotion in this context can be triggered by perception, imagination, anticipation, or an action. In psychophysiological research, body signals are then measured to understand what mental processes are connected to the responses from our bodies with one of the following sensors.

Generally, we assume that physiological responses are unprompted and spontaneous. As such, it is quite difficult to fake these responses, which make physiological measures more objective than, for example, behavioral gameplay metrics, where a participant is able to fake doing an activity while cognitively engaging in another. When using physiological sensors for evaluating player experiences, we need to have a controlled experimental environment, because physiological data is volatile, variable, and can be difficult to correctly interpret. For example, when participants talk during an experiment, this might influence their heart rate or respiration, resulting in altered physiological signals. As games user researchers, we also have to understand the relationship between how our mind processes information and the information responses that our body produces. The psychological effect or mental process is not always in a direct relationship to the underlying brain response. As such, we need to be aware that we cannot map physiological responses directly to a discrete emotional state. However, we can make inferences about emotional tendencies using physiological measures.

Unfiltered physiological signals measured from electrodes on the human skin are not more than positive or negative electrical voltage (Nacke 2013). These signals are generally characterized by their amplitude (the maximum voltage), latency (i.e., time from stimulus onset to occurrence of the physiological signal), and frequency (i.e., the number of oscillations in a signal). Before the signals become useful for analysis, they are usually processed and filtered. More intense experiences yield more intense responses in the physiological signals. There are some minor differences between some of the major physiological signals.

Electroencephalography (EEG)

EEG is currently not yet a common measure to analyze player experiences, because the brain wave activity that it records is hard to process and analyze. The resulting data can be very insightful into the cognitive processes of players, but it might also not be as actionable as other physiological data, because inferences depend largely on the experimental setup. EEG analyzes responses from a human's central nervous system, but it is less complicated to set up and less invasive than other measures, such as magnetic resonance imaging (MRI) or positron emission tomography (PET) scans. The temporal resolution of EEG is rather high compared to other techniques, which makes it especially useful for real-time feedback during gameplay. However, its spatial resolution is lower than other methods, resulting in low signal-to-noise ratio and limited spatial sampling.

Electromyography (EMG)

EMG sensors measure muscular activity on human tissue. This has many useful applications, but the main area of interest for games user researchers is facial muscle measurement. Our facial expressions are driven by muscle contractions and relaxations, which produce differences in electrical activity on the skin or isometric tension. This can then be measured by an EMG electrode. Our muscles contract, for example, as a result of brain activity or other stimuli, which makes them a primary indicator of peripheral nervous system activities. In game research, studies focus on brow muscle (*corrugator supercilii*) to indicate negative emotion and on cheek muscle (*zygomaticus major*) to indicate positive emotion (Hazlett 2006; Mandryk and Atkins 2007; Nacke et al. 2010a, b; Nacke and Lindley 2010).

Electrodermal Activity (EDA)

In physiological player evaluation, EDA measures the passive electrical conductivity of the skin that is regulated via increases or decreases in sweat gland activity (Nacke 2015). When a participant gets aroused by an external stimulus, their EDA will increase. The fluctuations of EDA are indicative of the excitement a player feels during gameplay. Often EDA is used to analyze the responses of players to direct events during a game; however, when we analyze those events, the delay of the signal has to be taken into account. So, studies often look at a 5–7 s window after an event has occurred to see what the physiological response indicates.

Physiological measures are powerful tools for analyzing player experience, but they are most useful when used in tandem with interviews or surveys to find out more about the subjective reasons behind the body responses recorded.

9.5.2 Surveys

The assessment of player experience by means of post-play surveys or interviews is the easiest and least expensive approach; however, it has some drawbacks. Since it relies on a player's memory, information may be lost in the delay between action (gameplay) and recall (interview or questionnaire).

The *Game Experience Questionnaire* (*GEQ*) developed by the FUGA group (Poels et al. 2008) consists of 36 items representing 7 scales: competence, immersion, flow, tension, challenge, positive and negative affect. The authors also offer shorter versions like the post-game experience questionnaire (PGQ; 17 items) and the in-game experience questionnaire (iGEQ; 14 items).

The *MEC spatial presence questionnaire (MEC-SPQ)*, by Vorderer et al. (2004), consists of 103 items and nine scales that measure attention allocation, spatial situation, spatial presence (in terms of self location and possible actions), higher cognitive involvement, suspension of disbelief, domain specific interest, or the visual spatial imagery.

The *Spatial Presence Experience Scale (SPES)*, by Hartmann et al. (2015), builds on the theoretical model of spatial presence (Wirth et al. 2007). It consists of

20 items and two scales that measure self-location (i.e., the users' feelings of "being there") and possible action (i.e., sense of being able to carry out actions and manipulate them).

The *Social Presence in Gaming Questionnaire (SPGQ)*, by de Kort et al. (2007), is based in part on the Networked Minds Measure of Social Presence (Biocca et al. 2001). It consists of 21 items and three scales that measure psychological involvement (empathy, psychological involvement), negative feelings, and behavioral involvement.

The *Game Engagement Questionnaire (GEnQ*), by Brockmyer et al. (2009), serves as an indicator of game engagement. The questionnaire identifies the players' level of psychological engagement when playing video games, assuming that more engagement could lead to a greater impact on game playing. It consists of 19 items that measure absorption, flow, presence, and immersion.

The *EGameFlow*, by Fu et al. (2009), measures the learner's cognition of enjoyment during the playing of e-learning games. It consists of 56 items and eight scales that measure concentration, goal clarity, feedback, challenge, autonomy, immersion, social interaction, and knowledge improvement.

The *Core Elements of the Gaming Experience Questionnaire (CEGEQ*), by Calvillo-Gámez et al. (2010), is used to assess the core elements of the gaming experience. It builds on the CEGE model described before and consists of 38 items and 10 scales that measure enjoyment, frustration, CEGE, puppetry, video-game, control, facilitators, ownership, gameplay, and environment.

Wourters et al. (2011) developed a questionnaire to measure perceived curiosity of players regarding serious games. The questionnaire contains seven items. The items were used as a single index for curiosity.

The *extended Short Feedback Questionnaire (eSFQ)*, by Moser et al. (2012), is used to assess the player experience of children aged 10–14 years. It consists of different parts to quickly measure the enjoyment, curiosity, and co-experience.

9.6 Fostering Player Experience

The previous sections articulated various ways on how to understand and examine player experience. This allows serious game creators to obtain insights into their game design; for example, a serious game designer might have created a game and consequently measured the player experience, gaining a better understanding of the overall product. However, she/he might then realize that the game does not achieve its objectives, i.e., it does not facilitate the desired player experience. The question is then, what does the serious game creator do?

One approach is to redesign the game, hoping that the measurements improve in a subsequent evaluation. However, such a redesign does not need to start from scratch. Like with the creation of the original design, there are several ways available to designers that can guide the design process to facilitate the desired player experience. For example, designers interested in facilitating a desired player experience can:

- learn from prior games. Game creators can look at (and play) other games and learn from bad as well as good examples.
- read post mortems as often published by game studios in industry publications, learn from them, and use them to inspire a (re)design.
- examine academic papers from serious game projects in a university or research organization setting. These academic papers often describe detailed learnings when it comes to fostering player experience and what the authors would do differently in future game designs.
- learn from books on game design.

Examining such guidance is worthwhile in the design and any redesign of a game. Furthermore, this guidance is applicable to both entertainment and serious games. It is important here that to address the serious component, game creators can look at specific guidance to complement the items detailed above. With the advancement of serious games, there will be more specific serious games guidance emerging to foster player experience. For now, however, we provide a couple of examples that aim to foster desired player experiences for specific serious game scenarios.

Fostering Player Experience: Example 1

Creators of serious games that aim to foster a desired player experience in movement-based games (for example, to facilitate positive health benefits) can look at the movement-based game guidelines developed by Isbister and Mueller (2014). These movement-based game guidelines emerged out of game design practice and research, and were developed with the help of industry game designers and user experience experts that were involved in some of the most popular commercial movement-based games to date—such as Dance Central, Your Shape and Sony's Eyetoy games.

The movement-based game guidelines are articulated in detail here, along with a website (http://movementgameguidelines.org/), and include examples and explanations. In this section, we highlight the key overarching points in order to inspire the reader to examine the guidelines further through these external references when needed.

The movement-based game guidelines are aimed to support creators of games where movement is at the forefront of the player experience. These games have been made popular by game consoles and movement-focused accessories such as the Nintendo Wii, Microsoft Xbox Kinect and Sony Playstation Move, however, they also apply to mobile phone developments that make use of sensing equipment that can detect movement or other technological advancements that enable movement-based games.

The guidelines are articulated in the form of heuristics, i.e., they are not required "must-dos," but rather guidance that designers should know about. As such, designers can break these rules; but first, they need to know the rules before they can break them.

The movement-based game guidelines can be grouped into these three categories:

- Movement requires special feedback
- Movement leads to bodily challenges
- Movement emphasizes certain kinds of fun

Each category has 3–4 specific guidelines:

Movement requires special feedback

- Embrace ambiguity
- Celebrate movement articulation
- Consider movement's cognitive load
- Focus on the body

Movement leads to bodily challenges

- Intend fatigue
- Exploit risk
- Map imaginatively

Movement emphasizes certain kinds of fun

- Highlight rhythm
- Support self-expression
- Facilitate social fun

To provide an example of the guidelines, we explain the first one, *embrace ambiguity*, in more detail. "Embrace ambiguity" suggests that "instead of fighting the ambiguity of movement, embrace it." Ambiguity in movement-based games arises from the fact that (a) no two movements are the same and (b) most sensor data is messy. Therefore, trying to force any precision might only frustrate the player and make the sensor limitations obvious in an un-engaging way. Therefore, the guideline suggests that instead of trying to eliminate the ambiguity, to work with it in a way so players can enjoy the uncertainty and figure out optimal strategies to cope with it.

The guideline also provides do's and don'ts; here, it proposes a very practical don't for the development process: don't use buttons during the early development phase (even if it seems easier), as the designer might miss opportunities that might arise from dealing with ambiguity (Mueller and Isbister 2014).

Fostering Player Experience: Example 2

Another example of guidance for facilitating a certain player experience is the work on applying game design knowledge to the creation of more playful jogging experiences. The work draws from the "non-serious" knowledge on designing games as articulated in the game design workshop book by Fullerton et al. (2004) and examined how it could be applied to the design of games that are situated in a jogging context. The authors draw on their prior experiences of designing jogging systems that aim to rekindle the playful aspect in jogging, and adopt the game design guidance to make it applicable to the design of such jogging systems.

The original game design workshop book proposes that game designers need to consider two key aspects (there are more, but we focus on these for now) in every game: *formal elements* and *dramatic elements*. Formal elements provide the underlying structure of the game (considering aspects such as objectives, rules, and outcomes) whereas dramatic elements are concerned with the visceral excitement that unfolds throughout the player experience. When applied to jogging, the authors describe how a look at formal elements can describe the "usability" tools in the designer's toolkit, whereas the dramatic elements make the "aesthetics" of jogging, describing the experiential tools in the designer's toolkit. These dramatic elements are important, as they allow the creator of the serious game to see the jog beyond a series of strides towards gaining a view on the overall physical activity experience.

Some examples of formal elements are: "the social jogger," which asks "who is involved in the jog?" and "the joggers' objective" that examines "what is the jogger striving for?" The "jogger's conflict" asks "what is in the jogger's way?" while "the jogger's resources" asks "what assets can the jogger use to accomplish the objective?"

Some examples of the dramatic elements are: "the premise of the jog" asks "how to support the setting of the jog" "the jogger's character" asks "who is the jogger?" and "the story of the jog" examines "how to support the jog as a narrative?"

By considering both the formal and dramatic elements, creators will be guided in their endeavor to facilitate the player experience they are striving for in their design.

Fostering Player Experience: Example 3

Another example of how to foster player experience in serious games is through considering the game features Reeves and Read (2013) articulate in their book "Total Engagement: How Games and Virtual Worlds are Changing the Way People Work and Businesses Compete." In this book, the authors propose that companies can draw on games to advance their business, a typical scenario for serious games. In order to guide the creators of such games, they list "ten ingredients of great games" and articulate why they are particularly important for businesses. These ten game features "to guide real work" are:

- Self-representation with avatars
- Three-dimensional environments
- Narrative context
- Feedback
- Reputations, Ranks, and Levels
- Marketplaces and Economies

- Competition under rules that are explicit and enforced
- Teams
- Parallel communication systems that can be easily reconfigured
- Time pressure

Each of these game features has a specific set of aspects to consider; for example, “Three-dimensional environments” are described further with the following aspects:

- Virtual space works like real space: No instruction necessary
- Three-dimensional space helps you remember where stuff is
- Special properties of virtual space (referring to the ability to go beyond copying the real world)
- Opportunities to explore
- The use of three-dimensional space can organize and inspire work

Overall, it should be noted that these features as well as their associated aspects are no guarantee for an engaging player experience. As Reeves and Read point out, they can guide creators of serious games based on the author’s knowledge and as suggested by prior research. However, they might not work in other, novel settings and contexts. Nevertheless, they provide a good starting point for creators of serious games when considering player experience.

Furthermore, it should be noted that not all of the features need to be present together, they can be considered individually and independently. The same applies to the suggested features and proposed guidelines described in the other examples: They are no guarantee for success. However, their articulation based on existing practice suggests that they can aid creators of serious games to facilitate the desired player experience.

9.7 Summary and Questions

Research on user experience as well as player experience has turned from usability and playability to the person of the user or player, respectively. Player experience is located at three interacting levels: the (socio-)psychological, behavioral, and physiological level. Player experience as an individual experience goes beyond playability and game usability. Psychological responses comprise cognitive, perceptual and emotional experiences like immersion, flow, challenge, curiosity, tension, positive and negative affects. Playing behavior includes all possible actions in and interactions with the game. Physiological responses range from peripheral reactions like changes in EDA and EMG to central reactions like EEG changes. Whereas psychological models of player experience focus on the multi-dimensional structure of individual player experience, integrative models address the holistic and interdisciplinary structure of player experience integrating the findings of numerous scientific disciplines, e.g., (neuro-)physiology, psychology, and sociology. The most useful for a shared understanding of PE is, therefore, to think about how these terms can provide a useful vocabulary for GUR when trying to improve video game design. This remains challenging as new models of PE are being developed and tested.

Guidelines and recommendations to foster player experience can be either derived from theory or from practice.

Check your understanding of this chapter by answering the following questions:

- What is the difference between usability and user experience?
- What is the difference between game usability, playability, and player experience?
- How can player experience be measured at the psychological, behavioral, and physiological level?
- What are the advantages and disadvantages of physiological compared to psychological measures of player experience?
- What are the advantages and disadvantages of psychological models of player experience?
- What are the basic assumptions of the following models: Self-determination theory (SDT), Attention, relevance, confidence, satisfaction (ARCS), Flow, GameFlow, Presence and immersion, Fun of gaming (FUGA), Core elements of game experience (CEGE), and PLAY heuristics?
- What are the characteristics of player experience?
- What are the added values of holistic models of player experience?
- What are the basic assumptions of the following models: ISCAL model, Dual-flow model (DFM), Four-lens model (4LM), Play Patterns And eXperience (PPAX) framework?
- How can player experience be fostered?
- What are the sources for guidelines to foster player experience?

Recommended Literature[1]

Bernhaupt R (ed) (2010) Evaluating user experience in games – Concepts and methods. Springer, London—*This book addresses both game researchers and developers. The book provides an overview of methods for evaluating and assessing player experience before, during, and after playing games*

[1]Issues of player experience are addressed at many conferences, ranging from the Games and Serious Games conferences mentioned in Chap. 1 to more specific conferences on usability, user experience, computer-human interaction (CHI) etc. Papers concerning player experience can be found in journals addressing human-computer interaction (e.g., Interacting with computers, Computers in Human Behavior, and International Journal of Human-Computer Studies), as well as journals specifically addressing games and serious games (e.g., Journal of gaming and virtual worlds).

Bernhaupt R (ed) (2015) Game user experience evaluation. Springer International Publishing, Cham—*This book is an update of the previously mentioned edition. Current developments in the assessment and evaluation of player experience are covered*

Fairclough SH (2009) Fundamentals of physiological computing. Interact Comput 21(1–2): 133–145—*This article gives a comprehensive overview of psychophysiological methods used for assessment of the current state of users and players, as well as their integration into adaptive systems. In addition, selected ethical issues are addressed*

Kivikangas JM, Chanel G, Cowley B, Ekman I, Salminen M, Järvelä S, Ravaja N (2011) A review of the use of psychophysiological methods in game research. JGVW 3(3):181–199—*This article gives a comprehensive overview of the psychophysiological measures typically used in game research. It also provides valuable information about the theories behind psychophysiological measurement*

Mäyrä F (2008) An introduction to game studies. SAGE Publications, London—*This textbook introduces students to the research field of studying games. The book delivers historical facts about (digital) games as well as basic knowledge concerning research methods for game studies*

Nacke LE (2009) Affective ludology: Scientific measurement of user experience in interactive entertainment. Blekinge Institute of Technology, Doctoral Dissertation Series No. 2009:04—*This dissertation is a comprehensive example of how the player experience can be investigated in practice. Various methods are thoroughly discussed concerning their research quality and systematically applied to selected research issues*

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