Design of Serious Games

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Philip Mildner and Florian 'Floyd' Mueller

Abstract

This chapter covers the topic of creating the design of a serious game. It first presents background information on games in general, and how they create engagement in particular—essential for serious games. The actual design process is similar to designing entertainment games; however, it differs when it comes to integrating the serious content itself. This chapter emphasizes these differences. It also presents solution strategies for how to create serious games. Beginning with an initial game idea, the steps of defining constraints for the game and adding suitable game mechanics are described. Finally, ideas are presented for how to organize the development process in a holistic approach, with a tight coupling of both the gaming and serious aspects.

3.1 How to Design a Serious Game

There are two main reasons to create a serious game for an application area. First, games in general create motivation, e.g., to get in-game awards, to beat the high score, or to be the best player in a multiplayer online game. Millions of players prove this fact every day. Serious game developers use these motivational aspects for other purposes than mere fun and entertainment. This does not mean that serious games should not be fun: on the contrary. Game designers, programmers, artists,

P. Mildner (✉)
University of Mannheim, Mannheim, Germany
e-mail: mildner@informatik.uni-mannheim.de

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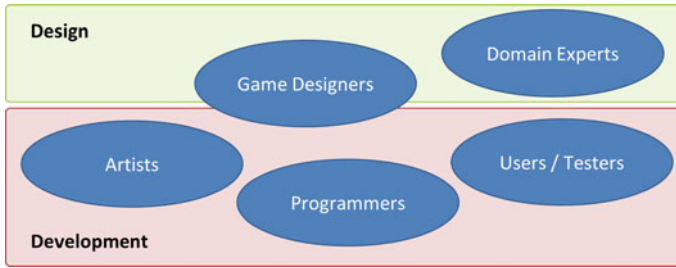RMIT University, Melbourne, Australia

Fig. 3.1 Involved parties in the development of serious games. Domain experts and users can be included into the process to different degrees, as described in Sect. 3.7

and domain experts have to work together throughout the entire development process to create an enticing game.

Moreover, in many cases, developers of serious games have to cope with limited budgets; the details are discussed in Chap. 11. This may result in a sub-optimal balance of the fun parts and the serious parts of the game, e.g., when there are no resources for hiring professional game designers or artists. Figure 3.1 gives an overview of all the involved parties that should work together in the development of serious games. This is very similar to entertainment games, the only difference being that in serious games domain experts are included for the serious part. In addition to these domain experts, game designers play a central role in the creation process. They are the ones who combine characterizing goals and entertainment parts. While details can still be changed during the development process, the big decisions—e.g., game genre, main story and game world—have to be set in the first phase. It is often the game designer's task to both create the design and to ensure the entire team works on it throughout the development phase.

When comparing the game design process of pure entertainment games with serious games, there are two main differences. First, as mentioned above, there is an additional party involved in the process, namely the domain expert(s). They are the ones that bring knowledge about the serious content into the design process. For example, when developing a learning game for schools, teachers take the role of the domain experts since they know what content should be included in the game, and how it should be didactically delivered to the students. Game designers have to cooperate with domain experts to create a meaningful game. Second, a serious game always has some goal or message in addition to the fun part. In the example above, it would be the goal of delivering the learning content to the students. It is the task of serious game designers to carefully connect both parts, so the resulting game is both enjoyable and meaningful.

In the remainder of this chapter, we will discuss the design process of serious games. The chapter provides a general overview, raises questions, and points out possible strategies by referring the reader to in-depth articles and books.

3.2 Game Characteristics

Playing a good game is fun. Prensky (2007) even calls digital games "potentially the most engaging pastime in the history of mankind." However, what exactly is it that generates fun in a game? Prensky separates fun into two components: *enjoyment* and *amusement*. Enjoyment means being engaged into something, while amusement denotes pure leisure. These two components are both used by opponents and proponents of serious games: Opponents only see the latter, thinking that such applications only pose a distraction without using the motivational aspects that result from the enjoyment felt. As games are closely related to pure amusement, there is also the belief that they cannot be used for something meaningful at all. If considering the enjoyment part, however, games go very well together with a serious purpose, e.g., learning. After all, children learn many things by just playing. Bisson and Luckner (1996) also note that fun is an important part when learning because it provides a relaxed atmosphere where learners are willing to learn. Salen and Zimmerman (2004) describe pleasure as "the experience most intrinsic to games." So while there are strong indicators that fun can indeed help promote the characterizing goal of a serious game, as discussed in Sect. 3.1, what exactly makes a game engaging and fun to play?

All games build on a common set of basic characteristics that distinguish them from play (Charsky 2010). As already mentioned in the introduction, *play* is a free activity that does not follow specific rules, and it is isolated from the real world by a *Magic Circle* (Huizinga 1955; Caillois and Barash 1961). Players do not have to follow rules and can use their imagination to freely play. A *game*, on the other hand, is a structured activity that follows certain *rules* and has a beginning and an end. Players have to use these rules to work towards a *goal*.

This basic model does not say anything about how a goal and rules could look to create engagement and enjoyment. Many models have been presented in the literature that examine game elements on a more detailed level regarding the fun they create:

- Caillois and Barash (1961) created a list of four elements: Agôn (competition), Alea (chance), Mimicry (role play), and Ilinx (vertigo).
- Apter (1991) created the following list: exposure to arousing stimulation, fiction and narrative, challenge, exploration, negativism (i.e., working against rules), cognitive synergy (i.e., inventive thinking), and facing danger.
- Hunicke et al. (2004) list eight elements of how games create fun: sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission.
- Prensky (2007) lists twelve elements: fun, play, rules, goals, interactivity, outcome and feedback, adaptivity, win states, conflict/competition/challenge/opposition, problem solving, interaction, and representation and story.

- Adams (2010) lists the following elements: gameplay, aesthetics, harmony, storytelling, risks and rewards, novelty, learning, creative and expressive play, immersion, and socializing.
- Fullerton (2014) defines the dramatic elements of a game as follows: play, challenge, premise, character, and story.

From this multitude of characteristics, a set of common denominators can be derived which will be presented in the following.

Play itself can be fun within a game. While games are a subset of the concept of play restricted by rules, playing without rules can or should also be a part of a game. Csikszentmihalyi (1991) therefore defined the term *autotelic*, a combination of auto (self) and telos (goal). Thus, players should be allowed to freely explore the game world and to experiment without fearing consequences. It does not matter if these actions arise out of pure curiosity and are just done because they can be done. To implement this characteristic, many games provide a *sandbox mode* where goals and some rules from the main game mode are disabled.

Although *rules* seem to limit players in their actions, at the same time they promise bigger satisfaction once the game has ended (Salen and Zimmerman 2004). By using stricter rules, the level of *challenge* is increased. In order to keep the players engaged, this level should not be too low to bore players and not too high to frustrate players, so that they stay in the *Flow* channel, introduced in Sect. 3.1 (Csikszentmihalyi 1991). If players are able to solve a challenge that is slightly too difficult for the perceived skill, they will feel rewarded and continue with the next challenge—maybe the next level or the next fight—in the game.

Everyone who has read a good book knows that *storytelling* is a strong engagement factor, and this is true for games as well. When drawn into a story, players want to know how it continues. The advantage of games is that players can influence the story by their actions. Closely linked to the story are its *aesthetics*. This includes the artistic style of the game, and especially how it presents itself to the players. An impressive graphical presentation alone can attract players to play a game.

Social factors are another characteristic that contributes to create a fun experience. By socializing, players build a team spirit if they successfully solve a task together with other players, e.g., a fight in an MMORPG where multiple players have to defeat a powerful enemy. In a team, players are able to do things that cannot be done alone. The interaction does not need to be performed with other players, though. Game characters can also be used when players can identify with them.

Even in pure entertainment games, the characteristic of *learning* is another engaging factor. Players feel satisfaction if they discover how to use a new game element or if they master the game by completing the last level. Some players invest a large amount of time to understand each and every rule, and they practice to become faster and better. It seems like a natural connection for serious games to use this intrinsic motivation to learn something new to achieve their goals.

Games, serious or just entertaining, are played because they are fun. This can be explained with different models that share common elements such as *play*, *rules*, *storytelling*, *social factors* and *learning*.

As mentioned above, games motivate players by including a variety of these elements. If this motivation does not come from an external source, but just from the game itself, it is called *intrinsic motivation*. Otherwise, it would be *extrinsic motivation*. So, when serious games are used as motivational tools, are they creating intrinsic or extrinsic motivation? The answer is not straightforward. When used mainly as a motivational tool, a serious game provides extrinsic motivation to its players. For example, a learner might not have a high intrinsic motivation to study for the next exam just by reading books. She might, however, be interested in playing a game where she competes against other students while learning for the exam. As soon as the exam is passed, the need for learning is over, and the player thus might end playing the game. This is extrinsic motivation, because the game is just regarded as a tool that helps to accomplish a certain goal.

But not all serious games have to follow this approach of "just being a tool." Games like *Civilization* or *Age of Empires* are good examples. These games deal with historic events in a playful manner and were successfully used in the classroom for teaching history (Squire and Barab 2004). In fact, there are people who state that the most they learned about history was by playing these games. The primary motivation to play these games, however, was most likely not to learn for the next history lesson, but just to have fun. Thus, the game can help to foster intrinsic motivation for the knowledge content because players then want to know more about a certain topic that was presented in the game.

Serious games can provide an extrinsic motivation to players who do not have an intrinsic motivation to engage with a topic otherwise.

Even though games can act as motivational tools, they do not appeal to every player in the same way. Some players like action games, others prefer real-time strategy games. Some like to play simple, casual games on their mobile devices while others invest a lot of money to have the fastest computer to play the most demanding and modern 3D games. There are as many different opinions about what the best game should look like as there are players. The age and gender of a player plays a large role in how highly they rate a game. For example, men prefer to have competition and spatial puzzles in games, whereas women prefer nurturing and verbal puzzles (Schell 2008). Also, children play different games than teenagers, adults, or the elderly.

In addition to such demographic factors, there are different psychological models that differentiate between player types. Bartle (1996) published a model consisting of four types, primarily targeting virtual multiplayer worlds: *killer*, *achiever*, *socializer*,

and *explorer*. A finer-grained categorization—again tailored towards MMORPGs—was presented by Yee (2006), working with the main categories *achievement, social,* and *immersion*. Even though both models were created for players in virtual online worlds/MMORPGs, they are applicable to other games as well. Fullerton (2014) lists ten player types for games in general. Thus, when designing a game, it is best to examine what type of players is most likely to be attracted by it, and whether these players match the intended target audience of the game.

> Different players are attracted to different games based on various factors, including demographic – such as age and gender – and psychological factors.

Another aspect to keep in mind is that there are not only different types of players, but also different ways of how players work with the characterizing goal of a serious game. When looking at the educational sector, there is a multitude of different teaching and learning techniques. Some learners like to learn in a group, and others prefer to study on their own in the quiet atmosphere of libraries. While some learners value the additional possibilities offered by serious games, others might be satisfied by studying a textbook. This does not imply that either of these types is worse or better. By increasing the set of different learning tools, however, a greater number of learners can be reached, and serious games can provide a way to open up a certain topic for a new group of learners.

3.3 Defining a Game Scenario

The creation of a serious game most likely starts with defining the characterizing goals. For example, a therapist might have the idea to create a new training application for elderly patients and to increase their motivation to exercise; she/he decides to implement it as a game. Another scenario could be a publishing house deciding to create a new learning game for a foreign language to accompany its existing learning materials. In principle, each game—serious or not—starts with this initial idea.

In entertainment games, it is the game designer who comes up with the first idea for a new game, defining its core idea (Schell 2008). In serious games, there is at least one predefined constraint: the characterizing goal. Further constraints include the determination of a specific target group or the setting in which the game will be played. Looking at our training game, the constraints are that the game should be used in therapy, and that it should be tailored towards elderly patients. The resulting problem statement thus might be the following: "How can the training outcome for elderly patients be improved by including game elements into the training process?" Even technical elements can be included here. For example, when it is clear that the game might be used in an environment where only outdated hardware is available, it does not make sense to design a game with extensive hardware requirements. Defining such a question is important because at any time during the design process it can be checked if the project still follows this initial question.

> Defining a clear *problem statement* helps to keep the design process and the project focused. In serious games, there is at least one *constraint* given by the characterizing goal.

Let us now look at another example, the learning game *Word Domination* (Mildner et al. 2014). This game was created in an academic setting without an external stakeholder. The main idea of the game arose out of two research questions:

- When creating a learning game, how close can it be to well-known entertainment games without sacrificing the explicit learning characteristic?
- How can the reusability of learning games be increased by offering an authoring interface that does not require any knowledge about programming or game design?

From these questions, several constraints emerge: The game should be based on a game principle often found in pure entertainment games, the characterizing goal should be *learning*, the game should allow for teacher-defined content, and entering this content should not require any changes to the core game logic. During the design process, the following decisions where based on these questions: One of the most popular game genres was used as the underlying game mode, namely a multiplayer first-person shooter. It was combined with a quiz game because this form of learning content can be used in a generic way and does not require any changes in the game, once implemented. Players have the goal of conquering platforms on a virtual map by stepping on them with their avatars. To hinder players of the opposing team from conquering a platform, a player can hit them by throwing balls at them. If they are hit, players are frozen in a glass bubble and have to answer a quiz question before they can continue conquering platforms. New quiz questions can easily be entered by the teacher on a web page, so no programming skills are required. In the end, all constraints were met with this game design, and the game is now available for anybody to use (Mildner 2014).

Most serious games are designed with a specific target group in mind. Whenever possible, the game should be crafted for the special needs and preferences of these users in order to be effective. Looking at the examples above, it would be the elderly patients for the training game. For the learning game there was no primary target audience defined, the game can be played by anyone. As discussed in Sect. 3.2, there are many different types of players and learners. Creating a game that fits all types of players is near to impossible because interests may not only be manifold but even conflicting. Instead, it makes sense to clearly decide on the intended target audience. If the designer has several audiences in mind it is important to concentrate on common denominators or non-conflicting features (Adams 2010). For example, when designing a game for children and their parents, it is a bad idea to include violence in the game because parents will reject this feature (and thus the entire game). Another trap independent game designers might

face is to create a game for themselves instead of the target audience. When male game designers create a game, they might include only the features that they like best, making the game appeal only to males, even though the target audience might have included women as well. Thus, it is a crucial part of the design process to get in touch with the target audience, perform interviews, and regularly test the game ideas with representatives of the group (Christel et al. 2015).

> When determining the target audience and investigating game elements attractive for this audience, game designers should keep in mind that they do not design the game for themselves – but for the players.

From the very beginning of the game design process, the different parties should work together. Especially, game designers and experts for the characterizing goal should cooperate closely when defining the problem statement and the target audience. This is a crucial step towards a successful game. It helps to interview experts and, in return, present and discuss early design drafts.

Once the key game aspects are set, the development team should be assembled. Obviously the team will not only play an important role during the entire development phase, but it can also influence the game design. For example, when there is a visual artist with a specific art style, the game could be designed around it. On the other hand, if the budget is small, and there are no dedicated artists available—a situation academic projects often face—this fact should be considered as well. As a consequence, the game might only use a simple graphics style, or reuse existing materials.

> Constant collaboration with the stakeholders (experts, developers, target audience) from the beginning of the design phase helps to keep design efforts on track.

An aspect of the game scenario can also be the intended play environment, i.e., the settings in which a game is played. Different aspects should be considered here:

- Supervision: Should the game be accompanied by an instructor (e.g., in a school environment or in therapy)?
- Environment: Should the game be played during leisure time or in a controlled environment?
- Re-playability: Is the game intended to be played just once, or should the game be repeatable (as a training application)?
- Timeframe: How much time should be available for playing the game?

Looking again at our training game, the following statement could thus be added to the design document: "The game is intended to be played by elderly patients at home for 30 min each day over a period of several weeks." If the game was

designed with a story that only lasted for a couple of hours, players would have to play the story again and again, so they would probably get bored soon. A session-based game with an ongoing story where parameters are changed for every new session (level, difficulty) would a better alternative for this scenario.

As some serious games are created with a specific research question in mind, for example in gamification, as explained in Sect. 3.1, the evaluation of the game is another important factor. For example, when evaluating long-term effects, the game should feature mechanics that keep players motivated over a long period of time. A question game designers also have to keep in mind is whether adapting a game to the players is desirable and feasible.

3.4 Experimental Game Design

As designing serious games is a creative process, it can be valuable to draw from the processes used by other creative practitioners. For example, designers can not only tap into practices used in the design of "regular" games (both digital and non-digital), but also from the design of interactive systems, industrial designs, or even architecture.

As it is a creative process, there is no fixed formal structure that guarantees success. However, over the years, techniques and strategies have emerged that support the creative process. Some of the strategies designers can employ are:

- *Examine (and play) other serious games for inspiration and guidance.* The serious games under investigation do not need to have the same characterizing goals. Being familiar with a broad spectrum of games can provide inspiration. For example, when designing a serious game for mental health, designers could be inspired by serious games for physical health.
- *Examine (and play) other games, including digital and traditional games*, such as board games and outdoor games. Investigating these games can lead to a rekindling of game enjoyment that could inspire new game ideas.
- *Examine traditional interventions in the corresponding "serious" field*, for example, games for mental health might look into mental health interventions such as regular meditation classes for inspiration. Although these interventions do not draw on "play" as a motivating factor, they often employ established theories that are deeply embedded in the structure of the intervention. As these theories have been used by other designers when they created the intervention, it could be useful for designers of serious games to learn from them: the creative process of turning an abstract theory into a practical intervention or into a game shares many similarities.

In addition to learning from previous approaches, there are also other ways to support the creative game design process. A popular approach is the use of Game Jams. Game Jams are fast-paced group activities in which small teams, typically three to five people, develop a game from concept to realization in a very short time,

such as 48 h (Goddard et al. 2014; Preston 2014). The teams are usually given a broad theme to start off with and then compete for a price of the best game at the end of the event. The time constraint, and consequently lack of sleep, often creates an intense atmosphere that celebrates the creative process with all its ups and downs. Serious game designers have adopted this format of game creation for their purposes. For example, the SwimGames initiative uses game jams to create physical games to address the sedentary lifestyle of young people in the Nether-lands (Deen et al. 2014). The advantage of Game Jams is that many games will be created in a very short time frame, usually one per team. These games are at least at a prototype stage, so they could be deployed to the target group and played by them to get feedback. However, game jams are not a sustainable model to produce high-quality serious games.

Using game jams for creating serious games comes with the challenge of how to introduce the "serious" component to the participating teams. Research workshops on this topic (Deen and Tieben 2012; Chatham et al. 2013) have begun examining this issue, as the requirements of a "serious" component can conflict with the traditional format of a game jam. The aforementioned introduction of a topic can inspire the participating teams, however, it might not provide enough guidance to fulfill the demands of the "serious" requirements.

Furthermore, academics have begun reporting on the design process of serious games (Isbister et al. 2010; Malone 1980; Rabin 2009). For example, Khaled and Ingram (2012) have reported that critical factors in serious game projects are project organization, technology, domain knowledge, user research, and game design.

Our recommendation to support the creative serious game design process is to make sure that the holistic approach to serious games is taken into account. This includes the full range of the process, including the ideation phase. It is advised not to fall into the trap of coming up with an idea for an entertainment game, and then sit back and think one can fit in the "serious" component in hindsight. The same applies to the opposite direction: a holistic approach also rejects the idea that designers can take a traditional intervention and fit a game on top. The design of a serious game needs to be an integrated approach, and the best way to achieve this is by taking a holistic approach from the start.

> The design process for serious games has to be treated in a holistic way from the beginning: Neither should the game be a mere add-on to the serious content, nor should the serious content be added to an unaltered entertainment game.

3.4.1 Practical Advice

We now present practical tips from our design practice that we believe have sup-ported the creative game design process, hoping that this might also help others in their practice.

- During the first stages of the ideation process, have tangible ideation tools ready at hand to inspire you. This can include not only pen and paper and other stationery, but also game figurines, play objects, etc. To complement these traditional design tools, we find it useful for serious game design sessions to also introduce underlying theories that might be considered in some tangible form or another. For example, a theory could be printed on a large sheet of paper, or its building blocks could be represented through Lego bricks that have labels attached to them. Such tangible objects support the participants to "play" with the building blocks that later form the serious game.
- Consider using technology inspiration. As most serious games utilize technology to make content more engaging, it could be useful to use the technology itself as inspiration. In order to facilitate this, engagement with the technology itself is needed as part of the creative process. This can involve introducing participants to novel technology, such as a new interface, explaining them how it works, and letting them playfully experience its capability and limitations.
- Ensure that domain experts take part in all stages of the design process to ensure that entertainment and serious content gets equal consideration. This can be challenging, as domain experts often have a different availability, schedules, and experiences with such processes—and possibly divergent expectations about how the process should work. However, even though this can require extra effort, the win in terms of a better game is worth it. Furthermore, working with domain experts throughout the process also advances a sense of connectedness and appreciation for each other, which contributes to the sense of having achieved the goal together. And if people believe in having achieved a goal together, they are more likely to invest in future activities, such as distributing the game among their contact circles, or even igniting further serious game developments.
- Consider strategies to gather a large number of ideas. We found that having more ideas to choose from is advantageous, and therefore recommend considering ways to facilitate the creation of many ideas, even though they might not be feasible, on-topic, relevant, etc. This follows the original brainstorming idea that more ideas are better, even if they are outlandish and will not be used. We agree with this idea that more ideas are better; after all, you can always throw ideas away. Similar to the brainstorming rule that no idea should be initially criticized, we suggest to develop an environment where a breadth of ideas is encouraged. Research on the value of multiple ideas shares our sentiment: it has been shown that having multiple ideas results in better outcomes than refining a single one during the same timespan (Dow et al. 2010).

3.5 Bringing Together Serious Content and Gaming

One of the key aspects when creating a serious game—maybe even the most important one—is the integration of the characterizing goal with the game content. Prensky (2007) calls this the "art" in the creation process. Without a successful

integration, the game will either be just an entertainment game or a (technology-enhanced) learning application. If done wrong, the resulting application will either not be fun to play, or will not help to promote the actual serious goal. For every new game, designers have to decide which path to follow.

A fundamental decision is whether the characterizing goal and game should be linked *statically* or *dynamically*. The former is the more common approach: Serious content and the game are designed and developed together from the beginning to the end of the product lifecycle.

A game to learn the Italian language can be used as an example. The game could tell a story about going to Rome and experiencing a series of events where players get to know Italian. The game would be accompanied by a matching story, artwork, soundtrack, and of course learning content. What, however, if the publisher suddenly decided to create a similar game that teaches Japanese? The entire process would have to start again from the beginning by creating a new story, different artwork, and so on. The changes do not have to be that big to run into problems, though. There might also be a situation where a teacher decides to use the learning game in an Italian class, but the learning content does not match her requirements well. If the learning content is statically linked, there is no way to easily change it.

The alternative is the dynamic integration of the serious content. The idea here is to provide a game where the serious content can be changed after the game has been created. The game then just consists of a set of predefined building blocks that can be filled with content later. Coming back to our example, the teacher might have to provide a set of pictures, a song and a list of vocabulary items and grammar exercises out of which the framework then creates a custom game. With statically linked games, there is a higher degree of freedom during the design process, and the game can have a deeper integration of serious content and game content. Dynamically linked games, on the other hand, allow for reusable game elements.

> When integrating serious content into the game, designers have to decide if the content should be linked *statically* or *dynamically* and how deeply both components should be integrated (intrinsic vs. extrinsic).

The decision to use a static or dynamic integration should not be confused with the integration of the serious content into the actual gameplay. Malone (1981) differentiates between *intrinsic* and *extrinsic* learning games (see Fig. 3.2). Intrinsic games
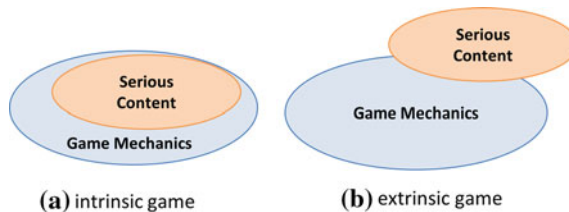

Fig. 3.2 Different integration strategies

provide a tight integration in a way that the gameplay is the characterizing goal itself. A popular example here is a flight simulator that is used for training pilots. Another intrinsic game is a multiplayer role-playing game that is used to train teamwork. In extrinsic games, there is only a loose connection or none at all. If, in the flight simulator, players had to answer questions about biology every 30 s, this would be a completely extrinsic game for teaching biology. It would not be a good game after all because the serious content is just used as a "blocker" for the main game to proceed, and players might see it as a punishment. A better alternative could be to use a "jump'n'run" game that takes place in a specific biological setting (e.g., the human body), where players have to answer related questions to defeat an enemy. The serious content and the game scenario get connected with this setting, but the actual handling of the serious content is still not the main component of the gameplay.

As described in Sect. 3.2, games are mainly played because they are fun. For many players it is just a leisure activity, not connected to studying or being confronted with serious content. Still, there are entertainment games that can be seen as serious games. *Angry Birds*, for example, teaches basic principles about physics and ballistics. *Dance Dance Revolution* promotes exercising, and it is actually used successfully as an *exergame* (Blumberg et al. 2013). Yet if asked, most players will probably not say that they just played a serious game. Although these games may not have been designed to be a serious game in the first place, they show how well serious content can be "hidden" within a fun game. In educational or learning games, this concept is sometimes called "*stealth learning*" (Breuer and Bente 2010). It can be used on purpose by designers of serious games. As with the decisions above, there is no right or wrong here, but the decision mainly depends on the intended usage scenario of the game. If a game is developed for classroom use, it might not be necessary to hide the fact that it is a serious game. On the other hand, if a game is supposed to incorporate stealth learning, but the integration is not done subtle enough, or the designers overshoot somehow, the following can happen: As soon as the players notice that they are supposed to learn something, they instantly boycott the game because they wanted to play a fun game, not a serious game. A better way to achieve the desired effect might be just to primarily design the game to be fun to play. If players really enjoy a game they will not mind if some serious content is contained in it. The best indication of this effect is if players notice only after playing the game that they have actually learned something useful. In other situations, users actively look for a serious game, e.g., to use it as a motivational tool. Then it is not negative if the game reveals its nature as a serious game. *Dr. Kawashima's Brain Training* published by Nintendo is an example for a specific learning game that is mostly played in leisure time. Thus, when deciding which of these paths to follow, it should be clear in what context the game is supposed to be used.

A serious game can either reveal itself as such, or hide the serious characteristic. The latter is called *stealth learning*. Both forms appeal to different user groups, and they are applicable in different situations.

Gameplay in digital games can be separated into *slow-paced* (e.g., in a turn-based strategy game) and *fast-paced* (e.g., in a racing game). Ideally, the way how the player interacts with the serious content should be reflected in the gameplay. Prensky (2007) differentiates between action games and reflective games. In action games, players have to react quickly, whereas in reflective games, players are allowed to think about the next move. This should be taken into account in the type of serious content. For example, when learning to type on a keyboard, users should be able to train typing actions without too much active thinking. Consequently, the game *The Typing of the Dead* combines this issue with an action game where players have to defeat approaching zombies by correctly typing words as fast as possible. In a setting where more thinking is required, such a game would be highly ineffective because of the built-in conflict: If players think too much they will lose the game, and if they do not think the game will not fulfill its purpose. To avoid such a mismatch, it should be clear which pace the serious content requires.

> The serious content and the game mechanics should follow a similar pace. For serious content requiring reflective thinking, a slow-paced game mode should be used. Fast-paces games should be chosen if fast reaction matters.

3.6 Game Mechanics

Chapter 1 already gave an overview of game mechanics. The combination of all game mechanics and game rules results in the gameplay that the players experience. They define what players can do in the game, how they perceive the game world, and what story they experience. This section gives an overview of common game mechanics.

Each game takes place in a *space*. There can be very different forms of such a space. In the case of a game with a physical equivalent it can just be a soccer playground or a chess game board. When it comes to virtual games, game designers have a high degree of freedom of how to create the game space. It can be as simple as a game board for playing TicTacToe, or it can be a complex 3D game world with a landscape, characters and objects in it.

A game space can be represented in different forms. Common techniques are to use a 2D or 3D environment that is rendered to the screen of the player through a virtual camera. Different perspectives are possible here: Top-down, first-person, flying camera, and so on. Yet other representations are possible as well: The game *Blindscape* (Blindscape 2015) does not use a graphical representation at all, but just provides acoustic feedback that is triggered by touching the black display of the player's mobile device. Apart from simple board-based games, the player is normally allowed to move in the game space. This can be done by controlling a virtual avatar or by using a birdseye view with a flying camera. Some games allow the

Fig. 3.3 Different representation forms of a quiz game: a 2D representation with a *three-in-a-row* game board (*left*) and 3D representation in a virtual world with a first-person perspective (*right*)

player to see and explore the entire space, while others limit the visibility by employing techniques such as *fog of war* (Adams 2010).

The decision for a characterizing goal does not imply the type of the game space. Figure 3.3 shows two completely different games that share the same basic principle, namely a quiz game. The first game uses a simple 2D space with no option for the player to move in it. In contrast, the second game takes place in a virtual 3D world where players experience the first-person perspective of a moveable avatar to perform actions in the world. The decision for one or the other game space can depend on the preference of the target audience (casual or hardcore gamers) or the intended hardware (mobile devices or desktop PCs).

If not working with an abstract game principle, there are normally *characters* in a game, as in the example shown in Fig. 3.3 (right). This includes the player character (or avatar), non-player-characters (NPCs) controlled by the game, or other human-controlled characters in a multiplayer setup. There are few limitations on how these characters can be modeled. An early and simple example of "characters" in games can be seen in *Pac-Man*. The game includes an avatar that is controlled by the player (Pac-Man) and four NPCs (the ghosts). Even though the NPCs follow very simple rules, players seemingly observe complex behavioral patterns with them (Millington and Funge 2009). Modern games normally include much more complex character types that can speak, express feelings or perform complicated actions, making them comparable to characters from novels or movies. Players may control one hero or even a group of them that become more powerful as the game proceeds. If players do not control an avatar directly, they often take the role of a director that can influence parts of the game (e.g., giving commands to NPCs, building structures, etc.).

Both the game world and the characters contribute to the *story* of the game. The element of story includes two aspects: narrative, and progression in the game. The narrative uses common storytelling techniques also found in novels or movies. During the game, players can experience an exciting story with dramatic elements. The *Hero's Journey* is a common template for creating an appealing story (Campbell 1968). It includes several stages where players experience ups and downs and grow more powerful until they face the final battle. Compared to
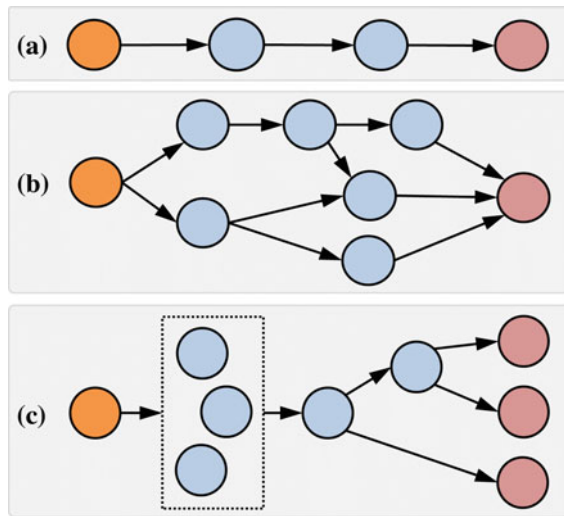
Fig. 3.4 Games with different forms of *progression*, reaching from simple linear layouts (**a**) to more complex layouts with branches (**b**) or level groups and alternative endings (**c**)

traditional media such as theater plays or movies, there is a fundamental difference: Games do not have to follow a linear way. This is a great opportunity for game designers because the story can change according to the players' actions.

This is where the element of *progression* comes into play. A game consists of at least one level or scene the players have to complete in order to win the game. Figure 3.4 gives an overview of possible progression types. The traditional way is a linear layout. Several levels are just connected consecutively, and players have to win all levels to win the game. More complex setups include branches where players can decide which path to follow. When applied to a role-playing game, for example, players could have to possibility join different factions. As a consequence, players will not be able to see the entire game content during one play-through. While this increases the re-playability of the game, it also increases the complexity and the design and development effort. Other progression types include level groups and alternative endings. In a level group, players have to solve a subset or all of the levels in an arbitrary order before they can proceed to the next stage. Alternative endings provide another way to increase the complexity and non-linearity of the story.

Independent of the extent at which characters and story are included in a game, players always perform *actions*. According to Schell (2008), the actions are based on a set of *rules* that determine what players are allowed to do in certain situations. As a result of an action, *objects* in the game alter their *states* and *attributes*. For example, in a soccer game, an action would be to kick the object "ball" because a rule prohibits throwing the ball. If done so, the ball changes its attribute "position" and enters the state "moving." Actions can be performed either based on *skill* or

based on *chance*. The soccer game is mostly influenced by skill. However, factors such as the wind can influence the game in an unforeseen way and thus incorporate chance-based actions. Actions and rules are elements that give a game structure and thus are an integral part of the game design. By changing the set of rules, very different games can be created while leaving the other game mechanics untouched. For example, a multitude of game modes can be created with the same deck of cards. Therefore, the core rules of the game should be designed carefully to reflect the original intention of the game, including transporting the characterizing goal.

> Common game setups include a *game space* and *characters*. Players can experience a *story* and perform *actions* in the space.

There are also different forms how players can interact in a game. If there is just one human player, the game mode is called *single-player*. Computer-controlled opponents can take the role of other players (NPCs). Examples for this mode are single-player racing games or strategy games. In both cases, the human player has to compete against an artificial-intelligence-based (AI) opponent. However, other games exist that do not require an AI component, like a simple card game or a puzzle game. Here, players just have to follow the game rules in order to win.

If the characterizing goal of a serious game depends on communication between players, a *multi-player* mode should be designed and implemented. We distinguish three different multi-player modes: In a *competitive* setting, players compete against each other, only one party can win the game. If a *cooperative* mode is used, players have to work together in order to win. This is similar to single-player games, only that there is more than one player who tries to be successful. A third form is the *collaborative* mode, which is slightly different from the previous mode: Although cooperative games have one common goal, all players have their own tasks which contribute to this goal. Such a game could look as follows: Players have to solve a set of puzzles to win, but solving each puzzle requires only one player. Thus, the game can be won faster when more players are in the game, but specific game actions are still smaller tasks in single-player mode. If, however, an action requires more than one player to collaborate, the game becomes *collaborative*. Wendel et al. (2013) used this approach to build a serious game to train team-building skills. Of course, combinations of the different modes are possible as well. For example, players might have to collaborate in a team while competing against another team. The design decision for what mode(s) could be used in a game should be based on the underlying serious content, so that the interaction modes of serious content and gameplay match.

Every game interacts with its players through an *interface*. It connects the virtual game space to the players' minds. For example, if a player has the thought "my avatar should go from one room to another," the game should provide a way to translate this thought into an action in the game. This includes both *input* and *output* interfaces. Common inputs are keyboard, mouse or game controllers. More recent

techniques include touchscreens, Microsoft's *Kinect*, Nintendo's *Wii Remote*, accelerometers found in mobile devices, and virtual reality controllers such as the *Rift* by Oculus VR (2015) or the Steam VR (2015).

The output component is responsible for showing the current game state to the player. As discussed in the section about game spaces above, the output can take different forms in terms of design, e.g., as a 2D or 3D world with different forms of cameras. The physical output normally is a screen. Still, it is important to consider its properties such as size (e.g., desktop monitor, mobile device or TV screen) and rendering capabilities (2D, 3D or virtual reality headset).

The decision to choose a specific input and output technology can be directly influenced by the characterizing goal of a serious game. For example, if it is a training game that involves whole body movements, the Kinect might be the best option. The technologies should also be matched with the target audience. When creating a game for users that are inexperienced with a PC, choosing a first-person controller with mouse and keyboard will result in a very steep learning curve; an alternative approach that just uses the mouse only might work better. Then again, game-experienced users might get frustrated by the missing degree of freedom. Available hardware can also be a limiting factor. For example, when a serious game is intended to be used in school environments with outdated hardware, this circumstance should be taken into account when designing the game.

Due to their interactive nature, games should always provide *feedback* to their players. Whenever players perform actions in a game, there should be some indication about them. This can be as small as highlighting an object after clicking on it, or as big as displaying the "game over" screen when the game ends. A good interface design also includes preparing players before important decisions. For example, if a game includes a story with branches, it is good practice to notify the players before they choose a path from which they cannot return so that they can think twice about their decision.

The level of immersion a user experiences depends on the implementation of the *user interfaces* (UIs), which comprises all menus and elements that are not directly part of the game world. Designing those in an intuitive way helps players getting along in the game. Players should know how to interact with objects in the world, or just where to find the settings menu to save or quit the game. There is a difference between UI elements that are part of the game world and those that are not. If players have to open a menu to perform a game action or change a setting, they will be drawn out of the game world and will lose the immersive feeling. The action of saving a game state can act as an example here: The common way to implement it is to provide a menu where the player can choose a "save" slot before returning to the game. This action breaks the immersion. If the game is an avatar-based game, saving can also be implemented without that break: A player could collect gems that can be used at certain locations to buy save-games. The same is true for including the serious content into a game. The interface to the serious part can either be plugged into an existing game as a menu, or integrated into the game world and its mechanics. When creating an educational game that includes a quiz component, there are different ways how to include the quiz into the game. If the game features

a world in which players can move and interact, an easy way would be to display a UI window that contains a question as soon as the player triggers an according action. The game would pause and continue as soon as the player answered the question. This approach draws players out of the immersion each time they have to answer a question. A better alternative would be the following: When players have to answer a question, they have to do that in the game world by jumping on a platform that represents the correct answer, or by destroying objects that do not contain the correct answer. In this way, game designers can create immersive serious game interfaces that create a seamless gaming experience for their players.

In an ideal world, game designers would create the perfect game by picking all of the best game mechanics. Unfortunately, a limited budget often does not allow one to do that. This is especially true for serious games that are often developed with a small amount of resources. As a consequence, it can make sense to concentrate on the most promising game characteristics. The presentation mode of a game is an area that allows for a variety of designs, e.g., when creating a game with a strong connection to the real world, such as a training simulation. The game design could look as follows: The player should be able to explore a city in which several points of interest are located. In each of these locations, the player should handle a situation connected to the serious content of the game. With the recent advances on 3D environments and virtual reality, it may be desirable to use these technologies for that game. Players could then freely explore a realistic virtual environment and feel almost as if they were really there. Creating such a complex environment, however, takes up a lot of resources. Furthermore, it bears the danger of *falling into the uncanny valley* (Tinwell 2015). This concept describes that the more realistic a computer-generated scene/object is, the more skeptical users are in accepting it. Thus, creating a realistic and believable virtual environment is a very complex task that requires considerable work from both programmers and visual artists. A more practical alternative could be the following: Instead of a complete virtual environment, players just see a map of the city where they can click on the different locations. Each location is then modelled by a set of panoramic images in which players can look around and interact with objects. The images can be shot at those locations with very little resources, and the result will probably be better accepted by the players than a not fully realistic virtual environment.

3.7 The Development Cycle

Most entertainment game design follows an iterative cycle in which the game is iteratively improved over time. This includes user testing, where players from the target audience play prototypal versions of the game, which provides feedback to help refine the game. Most serious game development processes follow a similar cycle; however, the challenge with serious games is that there is an additional stakeholder, the domain expert.

Moreover, many serious games target specific demographic groups that are different from the target group of traditional games. This can be challenging, as many game designers are used to designing games for players like themselves (and game companies often hire designers that design games they like themselves). This is usually not the case with serious games, where the game designers are often very different from the target group. So the question in the design process of serious games is: how does one design for the values and expectations of the different shareholders, in particular the players and the domain experts?

Participatory Design (PD) (Spinuzzi 2005) can help with this, as it is an approach to design for the values and expectations of specific audiences. Participatory design is a common approach for interactive systems in general, however, it is not as popular in the game design community (Khaled et al. 2014), probably for the reason outlined above: if the designers are similar to the players of their games, there is not much need to bring in additional players, especially when considering the resource constraints of many small game studios.

However, the consideration of participatory design in serious games is increasing (Khaled et al. 2014). Key themes here are that disempowered user groups should be empowered, and that diverse knowledge should be integrated. Furthermore, non-designer stakeholders should participate in design decisions that affect them. Khaled et al. (2014) also mention typical participatory design methods used in serious games: design games (Brandt 2006) and future workshops (Kensing and Madsen 1992). Moreover, it has been acknowledged that participatory design in serious games is not without its challenges, and the process rarely runs smoothly (Khaled and Ingram 2012).

In order to aid the use of participatory design in serious games, Abeele et al. (2012) developed a framework for the design of serious games. This framework proposes to build the serious game design on four conceptual pillars: player-centered, iterative, interdisciplinary and integrated.

- *Player-Centered Design*: The involvement of players should go beyond employing them to resolve usability issues, offering players the opportunity to participate also in the creative part of the game design process. This is important especially with serious games, as the target audience differs from the game designers probably more than in traditional entertainment games. The authors propose several methods to involve the players throughout the design process, including ethnographically inspired inquiries at the start of the project and participatory design sessions during the design phase, as well as user testing throughout the development.

- *Iterative Development*: The framework proposes an iterative and incremental approach to game design and development, consisting of three main phases: concept design, game design, and game development. The concept design phase is used to acquire an understanding of the player group and the problem domain. After the concept design phase has been verified, the game design phase transforms the concept into a detailed game to serve as input for the game developers. In the final game development phase, milestones and user tests are

defined, and the biggest risks the project faces in regard to serious goals, fun, and/or technological challenges are described. Concept design and game development typically last 3–6 months, and game development between 6–12 months.

- *Interdisciplinary Teamwork*: The framework suggests an interdisciplinary approach in which "all team members, not just the designers, participate in every aspect of the development process and learn from each other's field of expertise" (Abeele et al. 2012).
- *Integration of Play and Learning*: The framework proposes that play and learning needs to be integrated as closely as possible (Garris 2002). As the authors' background is in learning, it is not surprising that learning is featured here. However, we believe that the importance of integration equally applies to other "serious" content. This integration is facilitated by what they call "intense" collaboration between all the parties involved (Abeele et al. 2012).

This framework highlights the importance of bringing both players and domain experts into the game design process of serious games. To facilitate this, we now articulate four common ways how these can be brought into the design process, borrowing the categorization from prior work on co-designing with children by Hourcade (2008) and Druin (2002).

- *Stakeholders as users*: When players and domain experts are treated as users, they are often brought in at the beginning or end, utilizing them through ethnographies to understand how they currently engage with the "serious" aspect (beginning) and to assess its effectiveness (end). Both can be very useful for serious games, however, there are additional ways how stakeholders can be involved, which we describe next.
- *Stakeholders as testers*: When stakeholders are testers, they are invited to test prototypes and possible alternatives. This works well in the iterative process as the team gets feedback early, which reduces the overall cost and improves the quality of the final game. While this approach engages the stakeholders more, it does not provide them with a voice in the design process.
- *Stakeholders as informants*: When stakeholders become informants, they act as consultants to the team, sharing ideas at specific times. Common techniques are interviews, questionnaires, and focus groups. The Personas technique described by Antle (2004) can also be used to keep the different stakeholders in mind when they are not available.
- *Stakeholders as design partners*: When stakeholders join as design partners, they enter the highest level of involvement. As mentioned previously, the teams need to consider the different backgrounds and perspectives of the stakeholders in order to integrate them successfully in the design process; simply inviting them will not necessarily do. However, the outcome will be worth it, as all participants of the team will be able to fully buy into the process and thus in the outcome, facilitating the success of the game. Common techniques used here are contextual inquiry and participatory design. In contextual inquiry, players and

the entire team observe each other while playing the game to facilitate discussions on competing approaches. In participatory design sessions, prototypes are developed collaboratively to ensure that the stakeholders' diverse opinions are considered when it comes to feature selection.

In sum, the design of serious games can benefit from a player-centered, iterative, interdisciplinary, and integrated approach. Designers are advised to collaboratively engage not only the players, but also the domain experts, as they are both stakeholders in the process. This is a very different scenario from entertainment game design.

3.8 Conclusion

Game designers face a large responsibility: They lead the way for the entire development process of a game, from the initial idea to the final game. Therefore, they first should understand what makes a game a game, how it differs from play, and how it creates fun. This is especially important when designing serious games because they are frequently used as motivational tools to promote their characterizing goals.

The approaches differ slightly from game design for entertainment games. First, an initial game scenario is identified based on a set of problem statements. This scenario is then filled with ideas and game elements that are iteratively refined. With serious games, however, a very important part is the integration of the characterizing goal into the game. It begins with the definition of the game scenario, where the characterizing goal and the intended usage of the game act as additional constraints.

Keeping these constraints in mind, game designers create an initial game idea. Here, inspiration can come from looking at existing gaming and non-gaming applications. Furthermore, events like game jams can provide a series of prototype games in a short amount of time. Game designers also have to decide how to combine serious content and fun game elements. Both components can be linked statically to create a tight connection between them, or they can be linked dynamically to support interchangeable serious content and to enable the reusability of the game for different purposes.

When designing a game from scratch, a set of game mechanics have to be added to it. This includes basic elements such as a game space, actions and rules. More elements like a story, characters, or a multiplayer mode can be added to create more complex games. Interfaces provide functionalities for the players to interact with the game and give them feedback on their actions.

Once the first game design is finished, the development team can start to implement a first prototype of the game. The prototype is then iteratively improved until it becomes the finished game. Throughout the entire development phase game designers should constantly review the progress by talking to domain experts and

developers. Testing the game regularly with representatives of the target audience is another important step towards a successful serious game.

It is important to treat serious game design as a holistic approach from the beginning, integrating both the characterizing goal and the fun part. Consequently, the entire design process should also be holistic. Designers should bring together knowledge, props, and constraints from all involved stakeholders—including the stakeholders themselves.

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

- Why do games engage players? What components of the game attract players to invest such a large amount of time into them?
- Look at existing games (serious or not) and examine which game characteristics they employ.
- Formulate at least three game scenarios by exactly defining problem statements and constraints.
- Design the same game idea for different target audiences (e.g., tech-savvy teen-agers vs. elderly players) and different environments (e.g., classroom vs. leisure time). Do only parts of the design have to be changed, or do different audiences require completely different game types?
- Design a game prototype just by using pen, paper, and physical objects. Can you cover the entire game idea with that?
- Can any characterizing goal be turned into an intrinsic serious game, or are there limits regarding the set of available game mechanics?
- Match the pace of serious content and game. For example, choose from racing game, turn-based strategy game, platformer, first-person shooter, training vocabulary, physical exercises, learning how to do medical operations, learning how to drive a car, and acquiring a new language. Which elements can be connected naturally, and which are a poor fit?
- Look at existing serious games: Did they start as just the serious content, as an entertainment game, or were they created with a holistic design approach from the beginning?

Recommended Literature

Salen K, Zimmerman E (2004) Rules of play: Game design fundamentals. MIT Press—*Covers game design with a lot of background and theoretical information; a good introduction for readers interested in the core mechanics of games*

Fullerton T (2014) Game design workshop: A play-centric approach to creating innovative games, 3rd edition. CRC Press, Boca Raton, FL—*Presents the topic of game design with exercises, examples, and interviews from actual game designers. With this practical scope, it is especially suited for learning the basics of the creative aspects of game design*

Schell J (2008) The art of game design: A book of lenses. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA—*Builds up the game design process by working along so-called lenses,*

or small units of the process, and gives the reader many possibilities to reflect on the covered topics to get started with game development

Adams E (2010) Fundamentals of game design, second edition. Pearson Education, Berkeley, CA, USA—*Covers the topic of game design from a very technical perspective; suited for readers that want to start designing a specific game*

Prensky M (2007) Digital game-based learning. Paragon House—*A book specifically for learning games, describing theoretical foundations and different application fields. It is a useful resource when creating educational games*

Rabin S (2009) Introduction to game development, 2nd edition. Course Technology PTR, Boston, MA, USA—*Covers the entire game development process and thus provides a good overview beyond the scope of game design itself; helps to keep the big picture in mind*

Michael DR, Chen S (2006) Serious games: Games that educate, train and inform. Thomson Course Technology—*Gives a broad overview of the field of serious games and is a good introductory lecture for readers new to the field*

References

Abeele VV, De Schutter B, Geurts L, Desmet S, Wauters J, Husson J, Van den Audenaeren L, Van Broeckhoven F, Annema, JH, Geerts DP (2012) A player-centered, iterative, interdisciplinary and integrated framework for serious game design and development. In: Serious games: the challenge, Springer, pp 82–86

Adams E (2010) Fundamentals of game design, 2nd edn. Pearson Education, Berkeley, CA, USA

Antle A (2004) Supporting children's emotional expression and exploration in online environments. In: Proceedings conference on interaction design and children: building a community, ACM, pp 97–104

Apter MJ (1991) A structural phenomenology of play. In: Kerr JH, Apter MJ (eds) Adult play: a reversal theory approach. Swets and Zeitlinger, Amsterdam, pp 18–20

Bartle R (1996) Hearts, clubs, diamonds, spades: players who suit MUDs. J MUD Res 1(1):19

Bisson C, Luckner J (1996) Fun in learning: the pedagogical role of fun in adventure education. J Exp Educ 19(2):108–112

Blindscape (2015) http://www.blindscapegame.com/. Accessed 17 Feb 2016

Blumberg FC, Almonte DE, Anthony JS, Hashimoto N (2013) Serious games: what are they? What do they do? Why should we play them? In: Dill KE (ed) The Oxford handbook of media psychology. Oxford University Press, pp 334–351

Brandt E (2006) Designing exploratory design games: a framework for participation in participatory design? Proceedings ninth conference on participatory design: expanding boundaries in design, vol 1. ACM, pp 57–66

Breuer JS, Bente G (2010) Why so serious? On the relation of serious games and learning. Eludamos J Comput Game Cult 4(1):7–24

Caillois R, Barash M (1961) Man, play and games. University of Illinois Press

Campbell J (1968) The hero with a thousand faces. University Press, Princeton, NJ, USA

Charsky D (2010) From edutainment to serious games: a change in the use of game characteristics. Games Culture 5(2):177–198

Chatham A, Schouten BA, Toprak C, Mueller F, Deen M, Bernhaupt R, Khot R, Pijnappel S (2013) Game Jam. In: CHI'13 extended abstracts on human factors in computing systems. ACM, pp 3175–3178

Christel M, Trybus J, Shah SD, Chang BH, Dave R, Pavani A, Sawant, OD, Song J, Inglis J, Kairamkonda SS, Karrs C, Ke X, Kron E, Lu X (2015) Bringing biome exploration into the classroom through interactive tablet experiences. serious games. In: Huddersfield, UK, Göbel S, Ma M, Hauge J B, Oliveira M F, Wiemeyer J and Wendel V (eds) 1st joint internat conf on serious games JCSG (2015) Springer LNCS, vol 9090. Springer, Heidelberg/New York

Csikszentmihalyi M (1991) Flow: the psychology of optimal experience. Harper & Row, New York, USA

Deen M, Tieben R (2012). Swimitate Swimgames. http://www.swimgames.nl/. Accessed 17 Feb 2016

Deen M, Cercos R, Chatman A, Naseem A, Bernhaupt R, Fowler A, Schouten B, Mueller F (2014) Game jam: [4 research]. CHI '14 Extended Abstracts on Human Factors in Computing Systems (CHI EA '14). ACM, New York, NY, USA, 25–28

Dow SP, Glassco A, Kass J, Schwarz M, Schwartz DL, Klemmer SR (2010) Parallel prototyping leads to better design results, more divergence, and increased self-efficacy. ACM Trans Comput Human Interac 17(4):18

Druin A (2002) The role of children in the design of new technology. Behav Inf Technol 21(1): 1–25

Fullerton T (2014) Game design workshop: a playcentric approach to creating innovative games, 3rd edn. CRC Press, Boca Raton, FL, USA

Garris R, Ahlers R, Driskell JE (2002) Games, motivation, and learning: a research and practice model. Simulation and gaming 33(4):441–467

Goddard W, Byrne R, Mueller F (2014) Playful game jams: guidelines for designed outcomes. In: Proceedinigs 2014 conference on interactive entertainment, ACM, Newcastle, NSW, Australia, pp 1–10

Hourcade JP (2008) Interaction design and children. Found Trends Human-Comput Interac 1 (4):277–392

Huizinga J (1955) Homo ludens: a study of the play element in culture. Beacon paperbacks, Beacon Press, Boston, MA, USA

Hunicke R, LeBlanc M, Zubek R (2004) MDA: a formal approach to game design and game research. In: Workshop on challenges in game AI, association for the advancement of artificial intelligence. Miami, FL, USA

Isbister K, Flanagan M, Hash C (2010) Designing games for learning: insights from conversations with designers. In: Proceedings SIGCHI conference on human factors in computing systems. ACM, pp 2041–2044

Khaled R, Ingram G (2012) Tales from the front of a large-scale serious games project. Proc ACM SIGCHI, ACM, New York, USA, pp 69–78

Khaled R, Vanden Abeele V, Van Mechelen M, Vasalou A (2014) Participatory design for serious game design: truth and lies. In: Proceedings first ACM SIGCHI annual symposium on computer-human interaction in play. ACM, pp 457–460

Kensing F, Madsen KH (1992) Generating visions: future workshops and metaphorical design. L. Erlbaum Associates Inc

Malone TW (1980) What makes things fun to learn? Heuristics for designing instructional computer games. In: Proceedings 3rd ACM SIGSMALL symposium and the first SIGPC symposium on small systems. ACM, pp 162–169

Malone TW (1981) Toward a theory of intrinsically motivating instruction. Cog Sci 5(4):333–369

Mildner P (2014) Word domination. https://www.knowledge-gaming.de/. Accessed 17 Feb 2016

Mildner P, Campbell C, Effelsberg W (2014) Word domination: bringing together fun and education in an authoring-based 3D shooter game. In: Göbel S, Wiemeyer J (eds) Games for training, education, health and sports, lecture notes in computer science, vol 8395. Springer, Heidelberg/NewYork, pp 59–70

Millington I, Funge JD (2009) Artificial intelligence for games, 2nd edn morgan kaufmann series in interactive 3D technology. Morgan Kaufmann Publishers/Elsevier, Burlington, MA, USA

Oculus (2015) The oculus rift. www.oculus.com/en-us/rift. Accessed 17 Feb 2016

Prensky M (2007) Digital game-based learning. Paragon House, St Paul, MN, USA

Preston J (2014) Serious game development: Case study of the 2013 CDC games for health game jam. In: Proceedings 1st internat workshop on serious games. ACM Internat Conf on Multimedia, Orlando, FL, USA

Rabin S (2009) Introduction to game development, 2nd edn. Course Technology PTR, Boston, MA, USA

Salen K, Zimmerman E (2004) Rules of play: game design fundamentals. MIT Press, Boston, MA, USA

Schell J (2008) The art of game design: a book of lenses. Morgan Kaufmann Publishers Inc, San Francisco, CA, USA

Spinuzzi C (2005) The methodology of participatory design. Tech Commun 52(2):163–174

Squire KD, Barab SA (2004) Replaying history: learning world history through playing civilization III. Indiana University, Bloomington, IN, USA

SteamVR (2015) Steam VR. www.steampowered.com. Accessed 17 Feb 2016

Tinwell A (2015) The uncanny valley in games and animation. CRC Press, Boca Raton, FL, USA

Wendel V, Gutjahr M, Göbel S, Steinmetz R (2013) Designing collaborative multi-player serious games. Educ Inf Technol 18(2):287–308

Yee N (2006) Motivations for play in online games. Cyber Psychol Behav 6(9):772–775