Chapter 1
Assessment for Game-Based Learning

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1.1 Games: A Historical Synopsis

What is a game? Why do we play games? When do we play games? Who plays games? Games are a universal part of human experience and present in all cultures. Characteristics of a game include goals, rules, competition, and interaction. However, a historical synopsis of games shows that the conception of *game* and *play* changed during the centuries.

As games are associated with enjoyment, they are distinct from work (Ganguin, 2010). Looking at the ancient world (800 BC–400 AD), Platon describes a close connection between *play* (paidiá) and *education* (paideia). Games during childhood shape the future adult. On the other hand, Aristotle conceived the game as an opposite of learning. Therefore, learning is endeavor while games are recreation (Ganguin). Later, the Romans introduced the importance of games for the society by the phrase *panis et circenses* (bread and circuses, i.e., games). This phrase summarizes life in the Roman society. *Panis* reflects the free distribution of crop to the Roman citizens and *circenses* refers to the preferred entertainment, such as circus, chariot racing, stage plays (Bernstein, 1998). Apparently, games were utilized to distract the Roman people from politics. Moreover, Cicero suggested that games might cause buzz or exhilaration, and therefore games need to be controlled (Ganguin, 2010).

During the Middle Ages and the Early Modern Age, games were considered as a waste of time or even as evil as well as an expression of harmful nature

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(Parmentier, 2004). Accordingly, the notion of games lost more and more its positive meaning and the notion of work gained a much more positive meaning. During the thirteenth century, traveling artists were disenfranchised and minstrels were attributed as sinful people (Dirx, 1981). As a consequence, games were made illegal through local policy, because it stopped people from working. Later, Kant declared games as an enjoyable activity. Work and game were clearly delimitated. Following the argument of Aristotle, Kant attributed games being as relaxation; and disconnected it from work. Thus, Kant clearly stated that games did not have a positive effect on formal education (Kant, 1803).

The nineteenth century showed a recovery of the negative allocation of games. Fröbel (the founder of kindergartens) identified games as valuable for education and developed special games for children. Accordingly, the focus of Fröbel's educational theory was on games (Ganguin, 2010). During the twentieth century, the scientific controversy on games emerged. Freud used games to overcome psychological problems (Freud, 1920). *Homo Ludens* (first published in 1938) was regarded as a major work in game theory (Huizinga, 1955). Five characteristics of games were identified: (1) Playing a game is freedom, (2) playing a game is not *real* life, (3) locality and duration of games are distinct from *ordinary* life, (4) playing a game demands order absolute and supreme, and (5) playing a game is not connected with material interest or profit. Caillois (2001) criticized and extended the abovementioned characteristics of games because gambling, despite its focus on profit, was regarded as a game. Piaget (1975) considered play and imitation as two crucial functions in a child's intellectual development process: play as an assimilation strategy and imitation as an accommodation strategy. Further, he showed how variations of games are connected to the cognitive development. The *sensorimotor stage* is linked to *practice match*, the *preoperational stage* is linked to *symbol games*, the concrete operational stage is linked to rule-based games, and the concrete operational stage is linked to construction games (Piaget). Further, Dörner, Kreuzig, Reither, and Stäudel (1983) used games in their experimental studies to investigate the processes of complex problem solving. With the beginning of the twenty-first century, publications in social science focusing on games increased tremendously to approximately 20,000 in the last 10 years.

Looking at the historical synopsis of games, an antagonism between games (recreation, easy, fun, leisure, enjoyment) and work (effort, difficult, serious, profession, strain) is noticeable. However, another important question is present: How can a game be beneficial for life? In the foreground of this question are learning processes which may result from games—a game's hidden expedience (Scheuerl, 1988).

1.2 Games and Learning

A close examination of the history of the field of instructional design and technology (IDT) reveals an eclectic field with three main influences: instructional theories, learning theories, and instructional technologies (Fig. 1.1). At times, the developments in

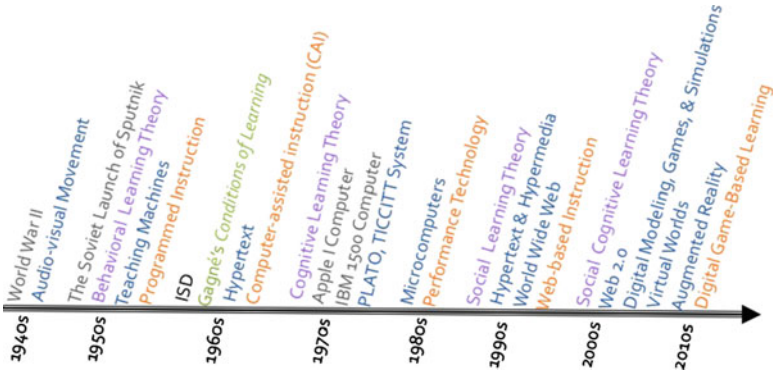

Fig. 1.1 Brief history of the field of instructional design and technology

instructional theories led the changes in the field driving the research and practice; other times it was the developments in learning theories. However, more often than not, biggest driving force in the field has been the developments in instructional technologies. More than we, the scholars and the researchers would like to admit it has been the developments in the technologies that has excited the field the most forcing paradigm shifts in the learning theories as well as in the instructional theories. It was the developments in the instructional technologies that have forced us to define and redefine what was meant by *learning* and *instruction*. It was the developments in the capabilities of instructional technologies that have enabled us to put into the practice these emerging conceptions of learning and instruction.

Recent years have witnessed yet another leap in technology, which many have argued are ushering in a new media paradigm (Galarneau & Zibit, 2007). Digital game-based technologies are nudging the field to redefine what is meant by learning and instruction. Proponents of game-based learning argue that we should prepare the students to meet the demands of the twenty-first century by teaching them to be innovative, creative, and adaptable so that they can deal with the demands of learning in domains that are complex and ill-structured (Federation of American Scientists, 2005; Gee, 2003; Prensky, 2001; Shaffer, 2006). Furthermore, proponents argue that games provide many of the essential affordances that are needed for learning in these contexts (Foreman, 2004) and that games are different from any other media because "one literally learns by playing" and usually does not sit down to read a manual first (Sandford & Williamson, 2005). Hence, it is argued that games could change education because it makes it possible to learn on a massive scale by doing things that people do in the world outside of school: "They make it possible for students to learn to think in innovative and creative ways just as innovators in the real world learn to think creatively…but they can do this only of we first understand how computers change what it means to be educated in the first place" (Shaffer, 2006, p. 23).

On the other hand, opponents of games argue that games are just another technological fad, which emphasize superficial learning. In addition, opponents argue that

Table 1.1 Emergent themes from the claims of games (adapted from Mishra & Foster, 2007)

Cognitive skills	Practical skills	Motivation	Social skills	Physiological
Innovative/critical thinking	Digital/technological literacy	Self-esteem/ confidence	Communications	Aggressiveness
Systemic thinking	Multi-representational understanding	Immersion (fantasy/ curiosity)	Interpersonal skills	Antisocial behavior
Inquiry skills	Expertise development	Immediate feedback/ scaffolds	Competitive behavior	Coordination
Deductive/ inductive reasoning	Innovative/creative design skills	Control, choice autonomy/ clear goals	Communities/ emergent culture	Motor skills
Metaphoric to model-based reasoning	Data handling	Discovery/ exploration	Civic roles/ duties/ informed citizenry	Violence
Causal/complex/ iterative relations	Multimodal literacy	Valuing	Collaboration	Obesity
Memorizing	Time management		Identity formation	

games cause increased violence, aggression, inactivity, and obesity while decreasing prosocial behaviors (Walsh, 2002). A comprehensive survey conducted by Mishra and Foster (2007) further identifies 250 distinct claims about games for learning. Using grounded theory analysis, these claims were categorized under five themes (Mishra & Foster): cognitive skills, practical skills, motivation, social skills, and physiological. Table 1.1 summarizes their findings. Careful examination of their findings reveals that, irrespective of which camp one may belong, there is a general consensus: Games can lead to changes in attitudes, behavior, and skills—isn't that how *learning* is defined?

As the border between *game*, *play*, *learning*, and *instruction* is getting blurry we are once again faced with paradigm shifts in epistemology, learning theory, and instructional theory. However, before we get excited like Edison did over educational movies and claim that digital games will change education we need to study what it means for instruction. A mature theory of game-based learning should take into account the underlying principles by which they work as learning environments. Despite the arguments for the potential of digital game-based learning, the empirical evidence for their effectiveness is scant (Eseryel, Ifenthaler, & Ge, 2011). Therefore, we argue for the need to systematically study, which instructional design strategies work in game-based learning environments to take full advantage of what these emerging technologies can offer for education and training. Towards this goal, a scientific attitude with regard to the design of educational games requires validated measures of learning outcomes and the associated assessment methods in order to determine which design elements work best, when, and why.

1.3 Implementation of Assessment into Games

The implementation of assessment features into game-based learning environments is only in its early stages because it adds a very time-consuming step to the design process (Chin, Dukes, & Gamson, 2009). Additionally, the impact on learning and quality criteria (e.g., reliability and validity) of technology-based assessment systems are still being questioned (Pellegrino, Chudowsky, & Glaser, 2003). Closely related to psychological and educational assessment of games is the requirement for adequate and immediate feedback while playing a game. It is considered to be any type of information provided to learners (Wagner & Wagner, 1985). Feedback plays a particularly important role in highly self-regulated game-based learning environments because it facilitates the development of mental models and schemata, thus improving expertise and expert performance (Ifenthaler, 2010; Johnson-Laird, 1989). Not only do new developments in computer technology enable us to dynamically generate simple conceptual models and expert representations, but also direct responses to the learner's interaction with the learning environment (Ifenthaler, 2009a, 2011). Nevertheless, dynamic feedback within a game-based learning environment presupposes a reliable and valid educational assessment (Eseryel et al., 2011).

Basically, we distinguish between (1) game scoring, (2) external, and (3) embedded assessment of game-based learning (see Fig. 1.2). First, game scoring focuses on targets achieved or obstacles overcome while playing the game (Chung & Baker, 2003). Another indicator for game scoring is the time needed for completing a specific task (Reese & Tabachnick, 2010). Second, external assessment is not part of the game-based environment. It is realized through (de-)briefing interviews (Chin et al., 2009; Ifenthaler, 2009b), knowledge maps (O'Neil, Chuang, & Chung, 2003) or causal diagrams (Spector & Koszalka, 2004), and test scores based on multiple-choice questions or essays (Schrader & McCreery, 2008). Third, embedded or internal assessment is part of the gameplay and does not interrupt the game. Rich data about the learner's behavior while playing the game are provided by clickstreams or log-files (Chung & Baker, 2003; Dummer & Ifenthaler, 2005). Another promising embedded assessment technique is information trails (Loh, 2006), which is a series of event markers deposited within any game at certain intervals over a period of time.

While assessment after learning in a game-based environment often focuses on the outcome, it may neglect important changes during the learning process (see Fig. 1.3). Accordingly, instructors and teachers can only compare the individual outcome with previous outcomes, check against other learners or experts. Still, this assessment method does not allow conclusions on the cause of a possible incorrect result. Did the learner not understand the task? Was the task too difficult? Was he or she too excited? Was it a matter of motivation? In addition, an educational assessment after playing the game cannot involve instant feedback while playing the game (Eseryel et al., 2011).

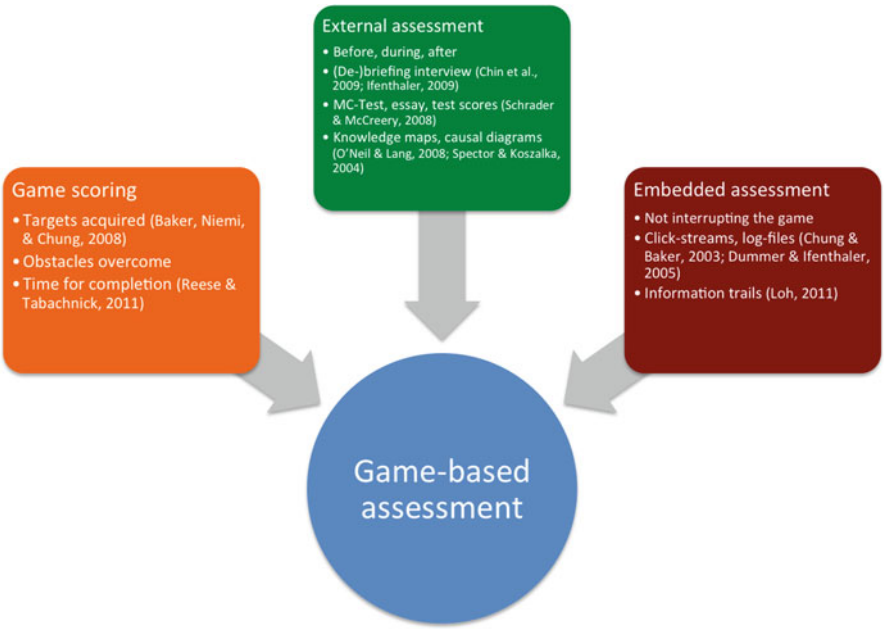

Fig. 1.2 Types of game-based assessment

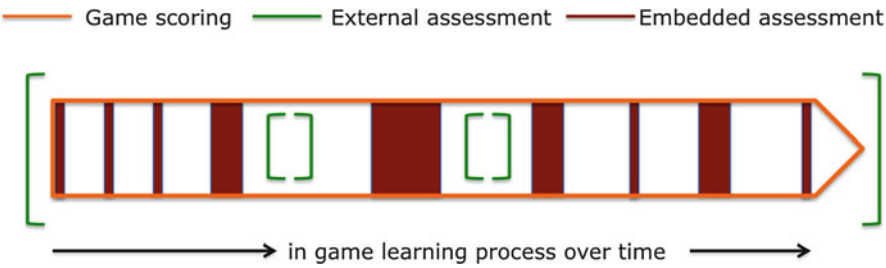

Fig. 1.3 Learning process and assessment

In contrast, assessment while learning in a game-based environment mostly focuses on the process. The benefits of this assessment method are manifold. Firstly, assessing learners while playing a game will provide detailed insights into underlying learning processes. Secondly, tracking motivational, emotional, and metacognitive characteristics while playing a game will help us to better understand specific behavior and the final outcomes. Thirdly, immediate feedback based on the embedded or stealth assessment can point to specific areas of difficulties learners are having while playing the game (Shute & Spector, 2010). Finally, assessment of *clickstreams* (Chung & Baker, 2003; Dummer & Ifenthaler, 2005) could point out strengths and weaknesses of the game design. Hence, an embedded

and process-oriented assessment must always include multiple measurement procedures which raises the question of reliable and valid ways of analyzing such longitudinal data (Ifenthaler, 2008; Willett, 1988) and provide instant feedback based on the individual assessment (Ifenthaler, 2009a). Such an intelligent assessment and feedback would result in an adaptive game environment, which changes in response to the learner's activity.

Intelligent assessment of game-based learning will be the challenges for the twenty-first century instructional designers and serious games developers. This edited volume will provide a first insight into the future developments of game-based assessment.

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