Chapter 2
Towards a Game-Based Learning Instructional Design Model Focusing on Integration

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Abstract This chapter focuses on a new instructional design model for game-based learning (GBL) that pinpoints the elements that are to be considered when designing learning environments in which GBL occurs. One key element of the model is discussed more in detail, being the integration of instructional elements in a GBLE. Based on different studies, the chapter concludes with emphasizing the importance of the design of the GBLE in the GBL processes. More specifically, the interplay between the instructional elements and the game elements is an important aspect in the GBL-process. Several decisions have to be made when designing a GBLE, and these decisions are of influence on GBL outcomes.

Keywords Instructional design model • Game-based learning • Integration of instructional elements

2.1 Introduction

To support students' development of knowledge and skills, educators are busy with developing learning environments. These learning environments aim at facilitating students' learning processes. Therefore, an optimal design of these environments is warranted. However, designing such learning environments is difficult, since many decisions have to be made based on different learning processes, different knowledge components, different teaching methods, etc. (Aleven, Koedinger, Corbett, & Perfetti, 2015). In order to support educators in this design process, different instructional design models exist. Some examples are the elaboration theory of Reigeluth (Reigeluth, Merrill, Wilson, & Spiller, 1980), Merrills' first principles of instruction (Merrill, 2002), or Gagné's nine events of instruction (Gagné, Briggs, & Wager, 1992).

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In these models, instructional designers try to outline ideal instructional methods for predetermined outcomes with a specific group of learners. Hence, these models give structure and meaning to instructional design problems and questions by breaking them down into discrete, manageable units (Ryder, 2015). The value of these models is determined by the context of use, since for instance, each model assumes a specific intention of its user (Ryder, 2015). This implies that the one "optimal" learning environment does not exist and depends on different aspects, e.g., the learners, the learning goals, and the context. This chapter focuses on a new instructional design model for game-based learning (GBL) that pinpoints the elements that are to be considered when designing learning environments in which GBL occurs. More specifically, one key element will be discussed more in detail, being the integration of instructional elements in a GBLE (see further). In this chapter, GBL refers to learning (outcomes) occurring from learning processes in which learners use an educational game.

Although general instructional design models can be used for GBL, specific models focusing on GBL have also been elaborated. One such GBL model is proposed by Garris, Ahlers, and Driskell (2002; the input-process-outcome model). This model tries to visualize how and when learning occurs when learners play a game. The input represents the educational game consisting of instructional content, mixed with game characteristics. During the game process, the learners are expected to repeat cycles within a game context. The learning outcomes, in turn, are conceptualized as a multidimensional construct of learning skills, cognitive outcomes, and attitudes. Another model of GBL is presented by Liu and Rojewski (2013). This model stresses that, in order to achieve GBL, an appropriate game design is essential, as well as an optimal game application or implementation. This indicates that not only the GBLE matters, but also the way the GBLE is applied or implemented in instructional activities.

Both models show a different elaboration of a learning environment in order to obtain GBL. However, they both emphasize the same basic idea: there is a need for a well-designed educational game environment, as well as for an effective game application. Hence, taking both models together, a new instructional design model for GBL can be constructed (see Fig. 2.1). The aspects that appeared essential in both models are also two central elements of the new model. However, a third key

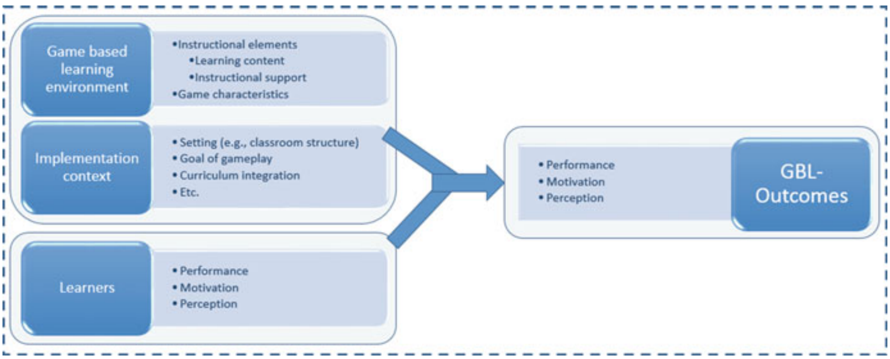

Fig. 2.1 Instructional design model of game-based learning

element is added to the model, being the learners. This element is not completely lacking in the two previous mentioned GBL models, but the learners were only included implicitly. However, because of the importance of this element, in the new GBL model the learners are not only implicitly included, but are incorporated as a third crucial element to be considered while designing for GBL. Finally, the learning outcomes are—in line with the two above-mentioned models—conceptualized as multidimensional: not only cognitive outcomes are assumed, but also motivational and perceptual outcomes are expected.

2.2 A New Instructional Design Model of Game-Based Learning

As is the case for all instructional design models, the above GBL model outlines the ideal instructional method since it abstracts from specific outcomes and specific groups of learners. By taking different aspects into account, a more encompassing picture of the implementation of game-based learning environments in educational settings is aimed at.

The first key element in the new GBL model is the educational game or the *game-based learning environment* (GBLE). In this chapter, both terms are used as synonyms. A GBLE contains—based on the two previous GBL models—instructional elements on the one hand (i.e., the material students have to learn from playing the game, e.g., learning content), and on the other game characteristics (i.e., the features that make the learning environment game-like, e.g., competition element). The instructional elements—in turn—consist of the learning content (i.e., the content in the learning domain the game is focusing on, e.g., proportional reasoning in mathematics) and the instructional support in the game. This support contains tools that are focusing on the learning content (e.g., correct answer feedback). The integration of these instructional elements in a GBLE is discussed more in detail in this chapter. The game characteristics contain all the features in the GBLE that make the environment game-like (e.g., storyline, interactivity, sensory stimuli). This also includes the tools that are implemented in the GBLE in order to facilitate the gameplay (e.g., tutorial with explanation about game functionalities).

The *implementation context* is the second key element of the proposed GBL model. Here, the focus is on the way the GBLE (first element) is used or applied, as GBL does not happen in a vacuum, but in a context. When two teachers use the same game in a different way, they create a different context out of which a different effect will most probably result. The implementation context is shaped by the setting (i.e., physical environment) in which the GBLE is implemented, the way the GBLE is presented to the students, the goal the educator wants to achieve, and by giving students gameplay opportunity and consequently the link or integration of the GBLE in the curriculum. Hence, a GBLE cannot be separated from the context in which it is introduced (Gee, 2011; Liu & Rojewski, 2013).

The third key element in the GBL model are the *learners* or the target group for whom the model is designed. This is done because developing learning environments requires to take into account individual differences between learners, such as differences in prior knowledge and in affective variables such as motivation (Shute & Zapata-Rivera, 2008). Furthermore, learners are active actors in learning processes (Lowyck, Elen, & Clarebout, 2004; Winne, 2004). Hence, instructional interventions (i.e., offering learners GBLEs) should not be considered as the direct cause of learner outcomes (Winne, 2004). As stated by Jonassen, Campbell, and Davidson (1994), "there is at best an indirect link between media and learning" (p. 36), and this link consists of the activities that are enabled by the media. So a direct effect of instruction on learning outcomes is not expected (Vandewaetere, Vandercruysse, & Clarebout, 2012). Rather it is the learners' perception and cognitions that affect the effectiveness of instruction. Notwithstanding the intentions from designers and teachers, the ultimate effect of instructional methods (i.e., using educational games) depends on—among others things—student' interpretation or perception of these GBLEs, rather than the GBLEs themselves. Hence, different interpretations result in different processes and products (Lowyck et al., 2004; Winne, 1987). Taken together, it is important to take the learners into account because interindividual differences in for instance perception may affect the learning results and hence the effectiveness of the intervention (Lowyck et al., 2004; Struyven, Dochy, Janssens, & Gielen, 2008).

As abovementioned, in this chapter, the first key element, i.e., the GBLE, is elaborated on, and more specific the integration of the instructional elements in a GBLE is further examined. Examining distinct elements is advocated. Up to now, no univocal definition or shared framework of educational games exists (Aldrich, 2005; Vandercruysse, Vandewaetere, & Clarebout, 2012). Based on such a framework however, educationally effective elements of a GBLE can be pinpointed, and hence, a first step towards an empirically supported conceptual research framework can be taken.

2.2.1 Game-Based Learning Environment

2.2.1.1 Instructional Elements: Learning Content

One of the instructional elements is the learning content. With respect to the learning content, two major aspects seem to be (1) the relationship between educational goals and the learning content, and (2) the suitability of integrating the learning content in a game context. Concerning the suitability of integrating the learning content in a GBLE, Malone (1980, 1981) and Malone and Lepper (1987) were the first to consider this problem of content integration in GBLEs. They state that the educational effectiveness of games depends on the way learning content is integrated into the fantasy context of the GBLE, and they propose the concepts of intrinsic and extrinsic fantasy to reveal an important distinction. This was further elaborated by Habgood, Ainsworth, and Benford (2005) and Habgood and Ainsworth (2011), who distinguish intrinsically and extrinsically integrated games. The emphasis switched from fantasy to the core game mechanics of digital games. Following their definition, intrinsically integrated games: "(1) deliver learning material through the parts of the game that are the most fun to play, riding on the back of the flow experience produced by the game, and not interrupting or diminishing its impact and; (2) embody the learning material within the structure of the gaming world and the players' interactions with it, providing an external representation for the learning content that is explored through the core mechanics of the gameplay" (Habgood et al., 2005, p. 494).

Extrinsically integrated games separate learning components and playing components. After completing one part of the learning content, students are provided with a reward by having the chance to advance in the game without dealing with learning content (e.g., playing a subgame). Clark et al. (2011) follow this line of thought and distinguish between *conceptually integrated* and *conceptually embedded games*. In the former, learning goals are integrated into the actual gameplay mechanics, whereas this is not the case in the latter. Holbert and Wilensky propose a new design principle in addition to the conceptually integrated or embedded distinction that was made by Clark et al. (2011). They argue that games should also be representationally congruent. "Representational congruent games are construction games where the player builds and/or interacts with the game using primitives relevant to the game world to construct representations that are congruent with those used by domain experts in the real world. In such games the primitives for construction embody the content (as in conceptually integrated games), but by putting them together in personally meaningful ways, the resulting representation has meaning outside of the game." (Holbert & Wilensky, 2012, p. 371).

The integration of learning content into parts of the gameplay (i.e., intrinsic integration) ensures, in principle, game flow experiences. Because of the maintenance of flow experience, intrinsically integrated games are argued to motivate and engage players more than extrinsically integrated games (e.g., Garris et al., 2002). Clark et al. (2011) as well as Habgood and Ainsworth (2011) found that intrinsically integrated games indeed engage players (i.e., primary school children) with the learning content in the game during a longer period of time. Besides students' motivation, playing with an intrinsically integrated game might also promote learning outcomes. For instance, Habgood and Ainsworth (2011) found a higher score on a delayed mathematical post-test in the intrinsically integrated condition than in the extrinsically integrated condition. Also Echeverria, Barrios, Nussbaum, Améstica, and Leclerc (2012) found that the game in which the content was intrinsically integrated was useful for increasing students' average test results and decreasing the number of students with conceptual problems. In the study of Clark et al. (2011), the learning progress was not as extensive as hoped for, but the learning during their intrinsically integrated condition seemed to have been supported. However, in a study involving vocational secondary education (VSE) students performed by ourselves, the opposite was found.

In this study, two kinds of GBLEs were studied: an intrinsically and an extrinsically integrated mathematical GBLE. Mathematics was selected as the GBLE content since this is a well-defined domain with specific applications (i.e., not too abstract). Additionally, the math domain chosen for this study (i.e., proportional reasoning) was relevant to the curriculum of Flemish VSE. Students enrolled in this system are expected to understand the proportional reasoning language and have to be able to solve proportional reasoning problems (Vlaamse Overheid, 2010). Based on the definition of Habgood et al. (2005), the mathematical content in the intrinsically integrated game was delivered through those parts of the game that are the most fun to play and embodied within the structure of the game and the players' interactions with it. Gaming and mathematical aspects cannot be separated from each other in this version of the GBLE. This means that the gameplay is not interrupted by the mathematical learning content because it is completely interwoven with the game mechanics and storyline. In the extrinsically integrated environment, the mathematical content was not part of the core mechanics and structure of the game, but was only introduced at the beginning of every subgame as a series of separate mathematical exercises. After students have answered these items, the game continues in the same fashion as in the intrinsically integrated version of the GBLE. However, in this version of the GBLE, they do not have to make any calculations as all the mathematical items are already presented to them prior to the subgames. See Fig. 2.2 for a screenshot from the intrinsically integrated version of the GBLE and the extrinsically integrated version of the GBLE. Hence, the study focused on whether integrating mathematical content (i.e., proportional reasoning) in a particular way (intrinsic vs. extrinsic) produced different effects.

The results of the study indicated that students playing in an extrinsically integrated math game showed higher learning gain, higher motivational gain, and higher perceived usefulness than students who played with the same math game but in which the content was intrinsically integrated (Vandercruysse et al., under revision). This effect of content integration was not completely in line with the previous mentioned literature data. At the outset, it was for instance assumed that intrinsically integrating the content would stimulate students and make them outperform those students who played in the extrinsically integrated condition. A possible explanation for the surprising findings is that, integrating the learning content into the game mechanics proved to be a complex and difficult process for our particular target group, i.e., VSE students with a significant number of at-risk youths (Vandercruysse et al., under revision). Students who play with this kind of GBLE experience more difficulties in learning the content because they simultaneously have to cope with two competing demands: the educational game and the gameplay elements (Shaffer, 2004). The difficulties students experienced in the intrinsically integrated condition frustrated them to such a degree that it reduced their motivation. Additionally, the exercise formats in the extrinsically integrated GBLE showed greater similarity with the items in the pre- and post-test. This might explain why students in the intrinsically integrated condition experienced more difficulties in transferring their mathematical knowledge from one context (the game) to the next (the paper-and-pencil test) (Habgood & Ainsworth, 2011). This might suggest that the specific

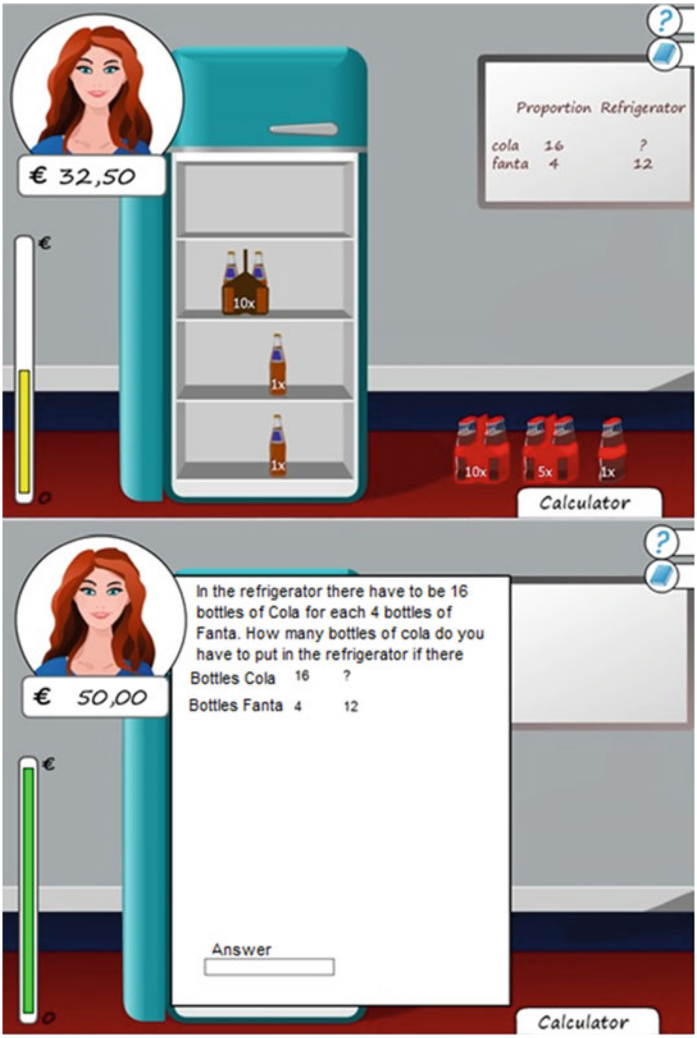

Fig. 2.2 Example of a missing value problem in the intrinsic (*top*) and extrinsic (*below*) integration versions of Zeldenrust

target group playing with the GBLEs might be of influence for the effect of the content integration in GBLEs on the GBL outcomes. Furthermore, questions may arise whether or not these findings can be generalized to other target groups. In order to elucidate these concerns, future research could focus on the impact of the integration of learning content and more specifically, whether the effect is dependent on the target group under investigation.

2.2.1.2 Instructional Elements: Instructional Support

In addition to the learning content, also instructional support can be integrated as instructional element in GBLEs. Instructional support, as defined by Tobias (1982, 2009) and Tobias, Fletcher, Dai, and Wind (2011), is any type of assistance, guidance, or instruction to help students learn. Examples are scaffolds, explanations, directions, assignments, background information, monitoring tools, and planning tools (Leemkuil & de Jong, 2011; Liu & Rojewski, 2013; Tobias et al., 2011). Adding instructional support is assumed to be a necessary part of GBLEs (de Freitas & Maharg, 2014) and is expected to stimulate or facilitate students' GBL (Ke, 2009). This assumption is confirmed by previous meta-analyses conducted by Ke (2009), Lee (1999), and Wouters and van Oostendorp (2013): simulation environments and games with instructional support can improve learning.

However, Wouters and van Oostendorp (2013) emphasize that adding instructional support to games is complex since the effect is dependent on *the type of support* and *the cognitive activities* they target, among others. Moreno and Mayer (2005), for instance, investigated the role of guidance and reflection as different types of support in GBLEs. A guidance effect was found, meaning that students achieve higher transfer scores, produce fewer incorrect answers and show greater reduction of misconceptions during problem solving when guidance is added (Moreno & Mayer, 2005), while the reflection effect appeared to be less consistent. Mayer and Johnson (2010) provided evidence concerning the instructional effectiveness of reflection prompts in the form of feedback on conceptual learning (Mayer & Johnson, 2010). Another study however established that reflection only promotes retention in noninteractive environments but not in interactive environments, unless students are asked to reflect on correct program solutions rather than their own (Moreno & Mayer, 2005). Reflection prompts as support in yet another study were ascertained less promising as they did not affect students' mathematical performance and transfer (ter Vrugte, de Jong, Wouters, et al. 2015). Furthermore, Darabi, Nelson, and Seel (2009) examined the influence of supportive information (i.e., a combination of instructional strategies offered to the students in the form of text, still pictures, and graphics of critical components of a complex system to explain the nonrecurrent aspects of problem solving in the domain of chemical engineering which was the subject of the study). The results indicated a change in players' mental models after the supportive information. Supportive information in the form of conceptual clarifications seemed to be less effective in a study of Vandercruysse et al. (2016). In this study, conceptual clarifications were added to the game as instructional support. For instance, the cognitive strategies that allow students to perform the tasks in the game and hence solve the problem were offered to the students, either in an internally integrated way (i.e., the support is integrated in the GBLE for instance as an interactive tutorial; see Fig. 2.3) or an externally integrated way (i.e., the support is offered to the students apart from the GBLE on handouts). Hence, the content of the support as identical in both situations, but the way the support was integrated, differed.

Results of the study indicated that adding conceptual clarifications as instructional support in an intrinsically integrated GBLE is not recommended for VSE students. If the support is given to the students anyhow, it is advised to offer it externally because internally integrating this support leads to a decrease in performance and motivation. A possible explanation is that the support was an embedded and programmed set of information given to all the students at the start of every new

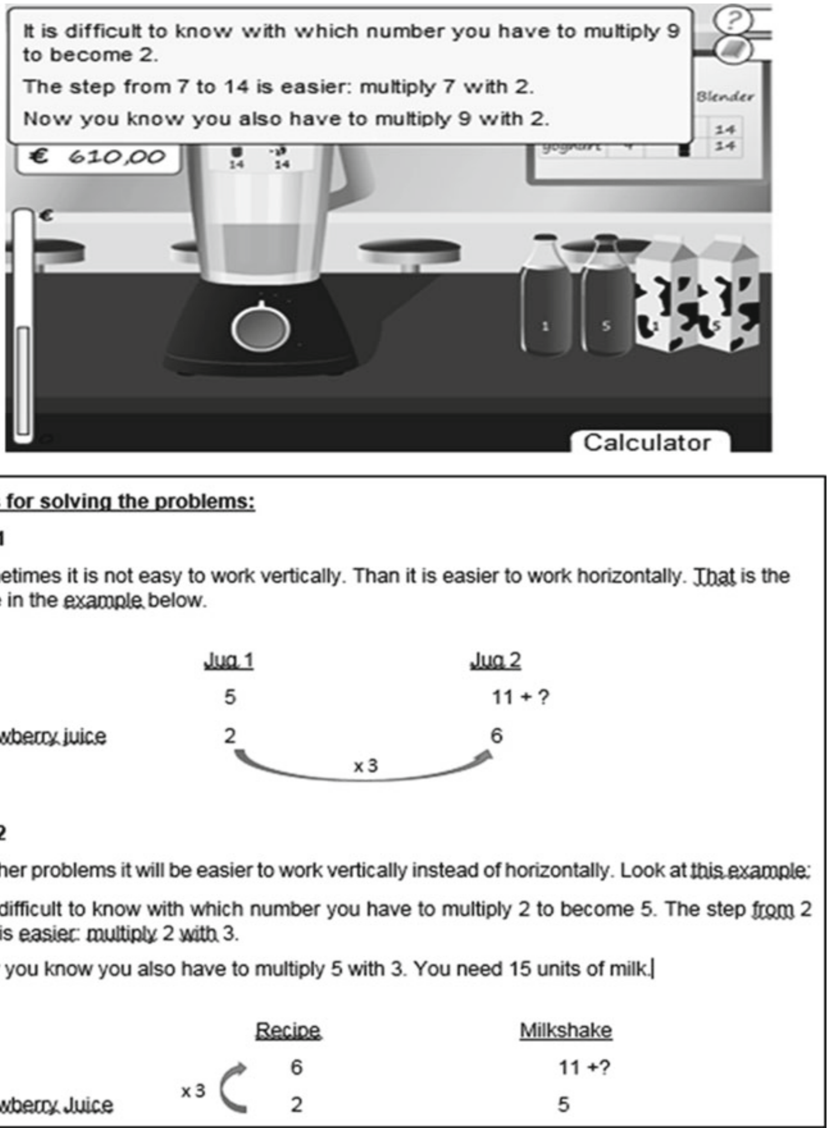

Fig. 2.3 Example of a translated part of the conceptual clarifications in the internally integrated condition and an extract from the handouts with conceptual clarifications in the externally integrated condition

subgame; irrespective of whether the players needed this information or not. Hence, the students in the ICC condition had to simultaneously cope with two forms of competing demands: the educational game with the integrated support and the gameplay elements (Shaffer, 2004). This might have been too overwhelming and have resulted in information overload. In the study of Darabi et al. (2009), problem-solving practice using a computer-based simulation was investigated as instructional support. Only a little change in mental model after problem-solving practice was established. Yet another study investigating additional practice (i.e., part-task practice) as support in a GBLE, found that practice makes better, i.e., VSE students who received part-task practice in the GBLE they played with, progressed more than the students without this additional support (Vandercruysse et al., n.d.). Part-task practice as support in this study was the integration of a series of items that provided training for a particular recurrent constituent skill (i.e., of proportional reasoning problems). Furthermore, this study also indicated that the way this part-task practice was integrated in the GBLE seemed to matter since it was found that students who received the internally integrated practice (i.e., practice that was integrated in the GBLE) improved more than the students with the same support but offered externally to the GBLE. Additional practice as support in combination with feedback was also investigated by Liu and Rojewski (2013). No effect of integrating practice and feedback in the game on participants' game enjoyment, academic achievement, or motivation was found (Liu & Rojewski, 2013). Procedural information—which was intended to aid the reflection process—had no additional value either (ter Vrugte, de Jong, Wouters, et al., 2015). Also the integration of learning units, which provide explicit instruction of the mathematical thinking strategies used in the game, did not lead to better learning outcomes between students playing with the GBLE alone and students playing with the GBLE in combination with the learning units (Broza & Barzilai, 2011). Charsky and Ressler (2011) moreover predicted that the use of concept maps would enhance the educational value of the gameplay activity; in particular students' motivation to learn through gameplay. However, the opposite happened: using conceptual scaffolds decreased students' motivation to learn through gameplay (Charsky & Ressler, 2011).

In short, the effectiveness of instructional support in games, as was also the case for the learning content, turns out to be unclear. These ambiguous findings might be a consequence of the diversity of the support (Leemkuil & de Jong, 2011; Tobias & Fletcher, 2012; Wouters & van Oostendorp, 2013). Besides the diversity of the support, another possible explanation for the ambiguity in the effects of support in GBLEs might be that two forms of integration of instructional support can be distinguished (Honey & Hilton, 2011; Ke, 2009; Liu & Rojewski, 2013). In some studies, the instructional support is internally integrated in the GBLE (e.g., Darabi et al., 2009; Johnson & Mayer, 2010; Lee, 1999; Liu & Rojewski, 2013; Mayer & Johnson, 2010; Moreno & Mayer, 2005, ter Vrugte, de Jong, Wouters, et al., 2015). In other studies, external instructional support is investigated (e.g., Barzilai & Blau, 2014; Broza & Barzilai, 2011; Charsky & Ressler, 2011). This type of support is offered to the students apart from the GBLE. There is no consensus about which type of support is the most effective. Some researchers advocate external integration (e.g., Barzilai & Blau, 2014), while others propose internal integration (e.g., Charsky

& Ressler, 2011; Liu & Rojewski, 2013). Barzilai and Blau (2014) for instance concluded from their study that external support might help learners to form connections between game knowledge and formal school knowledge, and hence improve their knowledge. Offering external support, such as concept mapping scaffolds in their study, might however also focus students' attention too much on the difficulty of the learning content and make the gameplay less self-evident (Charsky & Ressler, 2011). Therefore, Charsky and Ressler (2011) and Liu and Rojewski (2013) propose to integrate this instructional support internally into the game so it becomes an ongoing part of the gameplay. This might enhance learning and motivation. However, an important consequence of internally integrating support in games—in turn—is that, depending on the format and type of the support, it might disrupt the game flow because it demands too much processing capacity of the learner, and as in consequence the motivational nature of the game (Johnson & Mayer, 2010). Hence, depending on the type of support, the support needs to be integrated either internally or externally in order to be effective.

2.2.1.3 Game Characteristics

However, as can be derived from the instructional design model and as reviewed by Vandercruysse et al. (2012), a GBLE also contains other elements, being the game characteristics. Examples of game characteristics or elements are game rules, goals and objectives, feedback (i.e., game score), interactivity, game story, display system, and background music. Unfortunately, there is no agreement on what aspects are crucial to constitute an educational game (Vandercruysse et al., 2012). Some elements are already investigated in order to find the benefits of these elements. For instance, it was found by Richards, Fassbender, Bilgin, and Thompson (2008) that changes in pitch and tempo of the background music in educational games has no impact on learning outcomes. The display system, on the contrary, did evoke an effect on the feelings of immersion of the students (Richards et al., 2008). However, other elements evoke less conclusive findings (e.g., feedback in games; see Cornillie, 2014 for a thorough discussion about this element), or remain insufficiently investigated (e.g., game rules; Vandercruysse et al., 2012). Future research could focus more thoroughly on distinct game characteristics in order to be able to find, in addition to instructional elements, educationally effective game characteristics of a GBLE.

2.2.2 Implementation Context

Furthermore, focusing only on the design of the GBLE is too restrictive to capture the whole GBL-process. Also the implementation context is an important key element in the GBL model. The implementation context can be operationalized in different ways. For example, the implementation context might be examined by focusing on the way the game is implemented in the curriculum. Several authors (e.g., Baker &

Delacruz, 2008; Henderson, Klemes, & Eshet, 2000; Miller, Lehman, & Koedinger, 1999) already indicated the importance of integrating the game activities into the curriculum. When the gameplay is connected to the curriculum, the game is more likely to accomplish the intended instructional objectives because of the prompts that relate the game content to the curriculum. This prevents the learning processes from remaining simply inert (Tobias et al., 2011), which in turn stimulates transfer (Tobias & Fletcher, 2012). Although there appears to be consensus that games not connected to the curriculum are less likely to accomplish instructional objectives, research on the level of integration into the curriculum is largely lacking (Tobias et al., 2011). Therefore, Vandercruysse and colleagues (Vandercruysse, Desmet, et al., 2015; Vandercruysse, Van Cauwenberghe, & Elen, n.d.; Vandercruysse, van Weijnen, et al., 2015) had a try to fill the gap in this respect by exploring in three different studies possible ways of dealing with GBLEs in class and more specific, of integrating GBLEs in the curriculum.

In all three studies, curriculum was broadly interpreted as the range of activities and experiences offered at school and refers to the purposes, content, activities, and organization of the educational program enacted in the school by teachers, students, and administrators (Walker & Soltis, 1997). The first study addressed how the competition component of a game can be implemented in class by integrating rewards into the curriculum in different ways, and whether the way in which this competition is implemented matters. The focus was on competition because many researchers advocate a competition element in games (Hays, 2005). Competition is therefore incorporated in many games. However, scientific literature lacks consensus about the effectiveness of competition in games (Cheng, Wu, Liao, & Chan, 2009; Peng & Hsieh, 2012). Furthermore, the literature does not offer teachers an answer to the question about how to handle the game element competition in the classroom. Depending on the game environment, competition can be more or less emphasized, and might include rewards.

In their first study, the impact of integrating game competition in the classroom by assigning extra rewards was examined. In particular, the performance in the game led to an additional reward. In line with the findings of Hays (2005) and Tobias et al. (2011), the rewards were integrated in the curriculum in different ways. The other two studies investigated the effect of integrating a GBLE into the curriculum in yet a different way. First, a distinction was made between a strong and a weak integration by giving different instructions to the students during the intervention. The effect of instruction as support has already been investigated by Erhel and Jamet (2013). In their study, additional instruction in GBLEs seemed to have an impact on students' comprehension. More specifically, when instructions emphasized the entertainment nature of a GBLE, students performed significantly worse on memorization, in comparison to learners who received instructions focusing on the learning nature of the GBLE (Erhel & Jamet, 2013). This was further elaborated by Vandercruysse and colleagues. During the instruction, the GBLE the game content was linked in different ways to the math course in the classroom. However, this operationalization seemed insufficient and a more thorough game integration into the curriculum was carried through in the third and final study focusing on the curriculum integration. In order to attain this effective game integration, a more enhanced operationalization of the curriculum integration concept, based on the following three phases: (1) briefing, (2) playtime opportunity, and (3) debriefing (Felicia, 2011). In each of these phases, the teachers' focus is on attaining the educational goals and stimulating students' performance. Again a weak and a strong integration condition in the curriculum are investigated, using a different operationalization following the three phases of Felicia (2011). Hence, the focus is on the possible benefits for students of using a GBLE and more specifically whether integrating this GBLE in different ways (strong vs. weak) in the curriculum evokes a different effect.

The results of the three studies indicated the integration of the GBLE into students' curriculum has only minimal effect on GBL processes. None of the three studies could confirm the importance of the implementation context as a decisive variable for GBL. These findings are surprising, especially because of the importance that is often spent to the context in which learning occurs and because of the assumptions based on previous research that the curriculum integration should evoke some effect (e.g., Baker & Delacruz, 2008; Henderson et al., 2000; Miller et al., 1999).

However, the implementation context can also be operationalized alternatively. One alternative way is to investigate the setting or the classroom structure (i.e., the way the classroom activities are organized) in which the GBLE is implemented. An example is the work of Ke and Grabowski (2007). In their study, they addressed the combination of collaboration and competition in an educational math game for fifth-grade students. In particular, they explored whether computer games and collaborative learning could be used together to enrich mathematics education. The results indicated that the gaming context (collaboration or competitive) played a significant role in influencing the effect of educational gaming on affective learning outcomes. Concerning math attitudes, the collaboration condition promoted significantly more positive attitudes than the competitive or control condition. In the second study, Ke (2008) largely adopted the design of his previous study with the same target group. The cooperative condition remained the same but he divided the competitive group in two separate groups: an individualistic game playing group and a competitive game playing group. The research results indicated again that the classroom structure influenced the effects of computer games on mathematical learning outcomes and attitudes. Also ter Vrugte, de Jong, Vandercruysse, et al., 2015 explored the combination of collaboration and competition in GBL in a fully crossed design. Four conditions were examined: collaboration and competition, collaboration only, competition only, and a control group without competition and collaboration. It was found that learning effects did not differ between conditions (ter Vrugte, de Jong, Vandercruysse, et al., 2015). However, an interaction between collaboration and competition was found when students' ability levels were taken into account. Above-average students seemed to experience a positive effect of competition on domain knowledge gain in a collaborative learning situation. Below-average students showed a negative effect of competition on domain knowledge gain in a collaborative learning situation. In sum, the results of these studies indicate the importance of the classroom structure or the setting in which a GBLE is implemented, on the effectiveness of educational gaming. It shows also the importance of learner characteristics (i.e., ability level), the third key element in Fig. 2.1.

Though the different implementation choices of competition appeared of no importance in the results of the study of Vandercruysse, van Weijnen, et al. (2015), it might still be a relevant implementation context element when it is combined with collaboration. This could encourage further research based on different implementation context operationalizations. Only if the other operationalizations of the implementation context also appear to be unimportant in future research, removing the implementation context from the GBL model might be considered. Now, excluding the implementation context as important for GBL seems premature.

2.2.3 Learners

As mentioned above, individual differences between learners should be taken into account when developing learning environments because interindividual differences may affect the learning results and hence the effectiveness of the intervention. Especially, when very specific target groups are involved, this third key element might influence the GBL processes. Vandercruysse and colleagues conducted their research with VSE students. This group of students contain a significant number of at-risk students having encountered numerous unsuccessful instructional interventions and having grown resistance to traditional educational materials (ter Vrugte, de Jong, Wouters, et al., 2015). This causes among other things passivity or limited investment of effort (Placklé et al., 2014). This is aggravated by their focus on superficial instead of deep knowledge, routine instead of adaptive conceptually based approaches of learning content and by their (below) average cognitive capabilities (e.g., Cobb & McClain, 2005; Inspectie van het Onderwijs, 2009). These characteristics are specifically problematic for the acquisition of knowledge in difficult topics such as mathematics since they hinder growth in numeracy (Placklé et al., 2014). Another characteristic of VSE students is they often show a wide variety in cognitive abilities and potential (Placklé et al., 2014). It was found that students with different levels of mathematical ability are differently affected by playing with a GBLE (ter Vrugte, de Jong, Vandercruysse, et al., 2015; Vandercruysse et al., accepted). However, the findings in the studies using VSE students as target group, often deviated from assumptions based on literature and from previous empirical findings with other target groups. This might indicate the findings are target group specific: what works for VSE students does not necessarily apply to other target groups and vice versa (ter Vrugte, de Jong, Vandercruysse, et al., 2015). Because of this target group specificity, future research can focus on the specific differences between different target groups and hence investigate whether students from other education levels react similarly on the same interventions. This would enable us to pinpoint the decisive aspects of a target group for the effect of GBL and what students' variables (prior knowledge, motivation, previous gaming or school experiences, etc.) influence GBL outcomes.

2.3 Conclusion

In sum, the literature is inconclusive about the effects of instructional support and whether this support should be internally and/or externally integrated. Furthermore, the effect of intrinsically or extrinsically integrating the learning content is not yet sufficiently investigated. Nonetheless, the studies that are conducted reveal evidence for the importance of the integration of instructional elements, under certain conditions. Integration of instructional elements can happen in different ways (i.e., internal versus external or intrinsic versus extrinsic integration), and these options are decisive for the effect of the GBLE on the GBL outcomes. Further elaborating this undecidedness by examining distinct GBLE elements seems to be a promising manner to further fine-tune the effect of each of these instructional elements. Based on this kind of research, the educationally relevant elements of a GBLE can be pinpointed. This research method is advocated because up to now, no univocal definition or shared framework of educational games exists (Vandercruysse et al., 2012). Based on results of this type of research, effective parts of a GBLE can be identified and the first step towards a conceptual framework can be made. As Aldrich (2005, p. 80) stated, “Rather than thinking about games and simulations, it is more productive to think about the distinct elements.” This chapter has delivered an onset towards this for the choice of instructional elements in a GBLE. More specifically, it should first be decided whether the instructional elements are offered in the GBLE (i.e., internal integration) or in addition to the GBLE (i.e., external integration). Second—after opting for internally integrating the instructional elements—it should be decided whether the instructional elements are integrated into the game mechanics (i.e., intrinsic integration) or separated from the playing components (i.e., extrinsic integration).

To conclude, it seems that the way a GBLE is designed, and more specific the interplay between the instructional elements and the game elements are an important aspect in the GBL-process. Several decisions have to be made when designing a GBLE and these decisions are of influence on GBL outcomes. In addition to the importance of the GBLE design, also the implementation context and the players (the learners) are two decisive key elements in the GBL model.

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