

# SERIOUS GAMES DESIGN: A MAPPING OF THE PROBLEMS NOVICE GAME DESIGNERS EXPERIENCE IN DESIGNING GAMES

**Sevasti Theodosiou  
Ilias Karasavvidis**

Department of Early Childhood Education - School of Humanities  
and Social Sciences - University of Thessaly, Greece  
{theodosiou, ikaras}@uth.gr

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One of the main problems the field of Serious Game Design is facing concerns the gap between game design and educational design. It has become evident that to optimize the learning from serious games, pedagogical experts should be actively involved. There have been few documented systematic efforts to engage educators in the design process. To address this limitation, the present study examined the designs of 75 student teachers who attended an undergraduate course on game design. The aim of the study was to map out the difficulties teachers experience when tasked with the design of a serious game. The quality of the designs was determined by examining the presence of game elements and their interrelations. The findings suggest that while some of the designs were satisfactory, overall, the introduction of teachers to game design is challenging as pedagogical expertise does not appear to be directly transferable to game design. This study details the types of problems the teachers as novice designers faced and discusses the

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implications for future work.

## 1 Introduction

Multiple definitions have been given over the past years to describe Serious Games (SGs). Despite the different origin of each definition, the core meaning behind them is that SGs are games that can be used for reasons other than mere entertainment. In this context, SGs have been applied in a number of different sectors, such as healthcare, public policy, strategic communication, defense, training, and education (Zyda, 2005). In the education field, games in general have been proven to aid towards the development of strategic thinking, planning, communication, collaboration, decision making and negotiating skills of the player (Squire & Jenkins, 2003; Kirriemuir & McFarlane, 2004). In the past years, the potential support SGs can provide to learning has proven even more significant (Gee, 2003; Dondlinger, 2007; Steinkuehler & Squire, in press). Despite the great interest around educational SGs, the processes that lead to effective design still remain unclear. Linking educational design to game design is a significant challenge that requires the collaboration between experts of different fields. The participation of teachers in the design processes of SGs is promising as they are the ones to hold the instructional and pedagogical expertise. Even though a number of models have been created to compensate for their lack of experience, the problems they face when they are actively engaged in the process of SGD have remained uncharted. The present work contributes to this direction by examining the game designs student teachers make in the process of SGD.

## 2 Serious Game Design

One way of achieving optimal learning from SGs is to make their design optimal. The main difficulty with optimal design is that serious game design (SGD) is an interdisciplinary field, requiring the contribution of experts from many different areas such as graphic design, product design, programming, animation, interactive design, writing, audio design, and content areas (Salen, 2007). At the moment, the biggest gap the field faces is the disconnect between traditional game design and educational design (Arnab *et al.*, 2014; Bellotti *et al.*, Fiore, 2012; Van Staalduinen & de Freitas, 2011).

More specifically, as the success of the game industry attests, game designers can, obviously, make very engaging games. The issue is that engagement, as determined by flow, might not be sufficient for games to be effective for learning purposes. On the other hand, both domain experts and teachers have a firm understanding of how to design instruction on a given content. However,

they may lack the skills to translate academic content into gaming tasks and, consequently, make engaging games. Striking a balance between learning and fun is very challenging and requires the collaboration of experts from various fields. To bridge the existing gap, Charsky (2010) argued that game designers and instructional designers need to enter into a dialogue. This need is reflected in the various calls for developing a common language and vocabulary so that experts from various fields can effectively communicate and collaborate (Charsky, *op cit.*; Wouters *et al.*, 2011; Arnab *et al.*, 2014; Marne *et al.*, 2012).

As a rule, educational design has been mainly seen in terms instructional design and how it can be used to inform the process of educational game design (Van Staaldunin & de Freitas, 2011; Arnab *et al.*, *op. cit.*). Interestingly enough, a recent meta-analysis Wouters & Van Oostendorp (2013) confirmed the importance of instructional support in SGD. The authors concluded that learning from games is improved if instructional support is included in the form of modeling, modality, and feedback.

As teachers and educators in general are de facto the instructional design experts, many researchers stress the importance of involving teachers and domain experts in SGD (e.g. Bellotti *et al.*, 2012; Arnab *et al.*, 2013; Mawas, 2014; Marne *et al.*, *op. cit.*). The work reported in this paper follows this line of reasoning and involves teachers in game design.

### 3 Teachers as game designers

Due to their pedagogical expertise, teachers are being increasingly seen as essential for optimal SGD. Thus, one strand of research has aimed to facilitate teachers' and domain experts' participation in game design. The general idea is to lower the technical barrier for participation through specific software tools (e.g. <e-Adventure>, Moreno-Ger *et al.*, 2008) or methodologies e.g. WEEV, as methodology for facilitating educational game authoring by educators (Marchiori, *et al.*, 2012), the Six Facets, a framework for SGD (Marne *et al.*, *op. cit.*), and the Serious Game Logic and Structure Modeling Language (Thillainathan & Leimeister, 2014) for enabling educators to overcome the technical SDG barriers. While this approach is promising, it only successfully addresses technical participation barriers. However, there are many other challenges to overcome. More specifically, teachers' knowledge and skills regarding how to organize instruction on a topic may or may not be readily transferable to game design. For instance, one of the essential requirements of SGD is the intrinsic integration of content into the game (Malone, 1981) so that learning is seamlessly integrated with fun. The problem is that translating typical domain tasks into game tasks that are characterized by intrinsic integration is neither easy nor straightforward.

In this paper we advance the argument that, to make optimal designs, teachers (and novice designers in general) would need to have optimal support. To date, models, methods, materials, tasks, and strategies as well as other forms of support that might potentially scaffold teachers in their SDG venture have not been systematically explored. On the other hand, potential problems and pitfalls are not known. As teachers' experiences, perceptions, and approaches are not explored, this terrain remains largely uncharted and systematic research is needed. Similar arguments have been advanced by other researchers. As McMahon (2009) notes, there is little knowledge regarding the structuring that is needed to support novice designers, an argument that also applies to teachers. In a similar vein, Van Rosmalen *et al.* (2013) also argue that teachers can and should make serious games considering that nowadays it is relatively easy to circumvent existing participation barriers.

Overall, as engaging teachers in SGD is a relatively new approach, their successes and failures are not documented in the literature. The present study contributes to this direction by examining the problems student teachers experience when they embark on the process of SGD.

#### 4 Serious Game Design in Undergraduate Education

Considering the game design – educational design gap, Charsky (2010) argued that, to facilitate the connection between the two professional communities, specific courses need to be offered. There has been some interest in game design in undergraduate courses. The most typical examples come from Computer Science or other technical departments. In such courses games are introduced to situate domain learning in an attempt to make it less abstract and more meaningful (e.g. Coller & Scott, 2009; Eagle & Barnes, 2009; Schäfer, *et al.*, 2013). While the students in such courses do create games, gaming serves mostly contextualization purposes that are principally unrelated to game design *per se*.

The focus on game design is even less frequent in non technical courses. There are only few published examples involving undergraduates in the creative media fields. For instance, McMahon (*op. cit.*) reported a study of 20 participants who took a game design course at an Australian University. The author examined student uptake and use of a game design model he had developed (DOODEL), reporting positive findings. In a more recent study, Nash & Shaffer (2013) examined the mentoring of 7 undergraduate students at a European university in the context of a game design practicum. What is particularly interesting about such studies is the focus on actual game design *per se* rather than technical or other aspects.

## 5 The IGENAC Model

While over the recent years a few SGD models emphasizing educational design have been advanced, there is still no universally established educational paradigm for SGD. To scaffold teachers and domain experts in their introductory SGD ventures, we have used the Integrated Game Elements, Narrative and Content (IGENAC) model. This model has been explicitly designed from the ground up to integrate different game approaches and traditions (Karasavvidis *et al.*, submitted). Narrative, conventional game design, and academic content comprise the 3 main model dimensions that are situated in the context of a concrete sociocultural theory learning framework. The model is illustrated in figure 1.

As seen in figure 1, the model is presented as a network of interrelated nodes. Nodes represent game elements and arrows depict associations between game elements. Direct relationships are indicated with continuous lines, while indirect relationships are represented by dotted lines. Additionally, the colors of the arrows signify the dimension upon which the model draws.

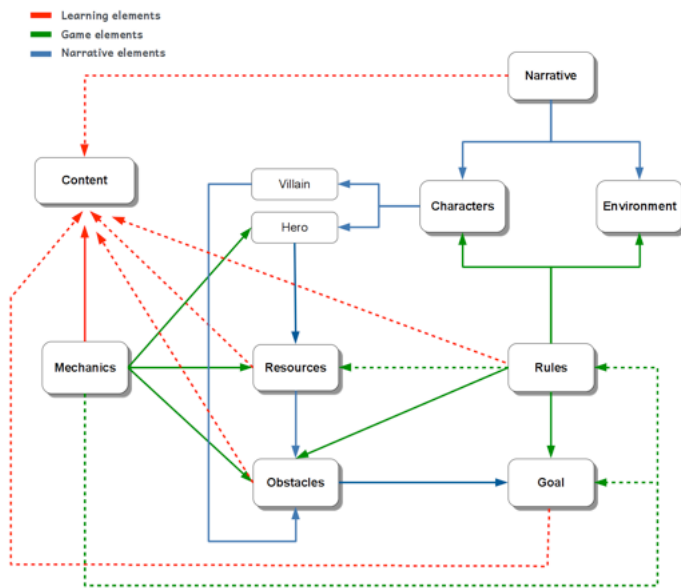


Fig. 1 - The IGENAC model

The model attempts to synthesize three different but interrelated strands of game design approaches and research: education, narrative, and conventional game design elements. More specifically, the narrative elements originate from

Dickey's (2006) design heuristics for integrating game design narratives into instructional games such as initial challenge, obstacles, challenges, resources, main characters, spatiotemporal dimensions of the environment, backstory, and cut scenes. The source of conventional game design elements such as resources, rules, obstacles, and mechanics is the standardized entertainment industry generic ADDIE models (e.g. Bethke, 2003; Salen & Zimmerman, 2004). Finally, academic content and the rationale of its integration in the game content, in an intrinsic way, is based on the work of Malone (1981). Sociocultural theory and in particular the concept of mediation provide a general grounding for this model. In the same way that a tool mediates the relationship between a subject and an object, the instrumental integration of content into SGs through narratives facilitates the direct correspondence between game mechanics and learning mechanics. Essentially, the model facilitates the instrumental use of resources to overcome obstacles in a principled, contextualized manner. The story of the game, along with the main characters (hero, antagonist) and settings (environment) are depicted in the narrative. The challenges (obstacles) the protagonist faces in the pursuit of his/her goals (goal) and the tools (resources) he/she uses in his/her encounters are also described. The interactions between those game elements are bounded by a set of operational and constitutive rules. Eventually, using the resources to overcome obstacles through game mechanics will lead the player to the learning of academic content. Overall, the specific model conceptualization affords the intrinsic content integration into game content through the combination of conventional game design, narratives and content. A comprehensive account of the model and the underlying rationale and principles is available elsewhere (Karasavvidis *et al.*, submitted).

## 6 Focus of study

Overall, while many sources recommend engaging teachers in SGD, we were unable to locate published studies in which educators (be it in-service or pre-service) were systematically introduced to game design. Thus, there is a knowledge gap regarding how well teachers actually perform when tasked to actually design an educational game. The present study addressed this gap by mapping out the difficulties novice game designers experience. The quality of game designs was examined by looking at their design documents (DDs). More specifically, the study aimed to answer the following questions:

- (a) which game elements are least integrated into the designs?
- (b) what is the quality of the game elements that appear in the DDs?
- (c) which are the least integrated connections between game elements into the designs?
- (d) what is the quality of the connections between game elements that

appear in the DDs?

## 7 Method

### 7.1 Participants and Context

Seventy-five students (all female, age range 20-22) participated in the study. All participants had enrolled in an undergraduate course on SGD offered at a preschool education department in a public university in mainland Greece. The 13 week, elective course aimed to introduce students to the theory and practice of game design for educational purposes and involved both lectures and lab sessions. The lectures covered the theory and research on SGD and introduced IGENAC. The lab sessions introduced students to a 3D game development pipeline. The students worked in small teams of 2-3 individuals. Their main assignment was to design an educational game for preschoolers and develop a playable working 3D prototype. The students were provided with a design document (DD) template, a concept map outlining the model and other learning materials (manuals, howto guides, and videotutorials). The main course deliverables were (a) the design document (DD) of the game and (b) a playable game prototype. Using the template, the students were asked to explicate their designs by describing the main elements of their games: narrative, rules, mechanics, and learning content of the game. The students were also asked to discuss in their DDs how the mechanics of their game would eventually lead to content mastery.

The procedure was implemented as follows. Firstly, after five weeks into the course, the students were asked to complete and submit a first draft of their DD. A teaching assistant (first author) was tasked with examining the initial DD version and provide detailed feedback. All the teams received comprehensive annotated comments on their DDs via email. This feedback consisted of detailed comments and questions on the designs that aimed to help them clarify or resolve potential ambiguities and/or misperceptions. In addition to annotated comments, optional face to face feedback sessions with the teaching assistant were also offered. Eventually, 29 out of 34 teams requested face to face meetings for interactive support. After the feedback sessions, the students were asked to revise their DDs. The final step involved the creation of a playable game prototype which was meant to materialise their game designs as reflected in their DD.

### 7.2 Measures & Analysis

For the purposes of this work, we limit our analysis to the initial DDs, because they provided a more genuine picture of the initial difficulties that

the students experienced as complete novice designers. In total, 34 DDs were analysed (N=34). The quality of the DD was operationalized in terms of: (a) the game elements included in the game and (b) the connections between those elements.

The underlying assumption is that to be complete, a game design should include both all the requisite game elements and explicit connections detailing the relations between the elements. The presence of a specific game element or a connection was defined in terms of its identifiable, discrete, and explicit appearance in the design. The quality of each game element and each connection between game elements was defined in terms of how well each game element/connection (a) was sufficiently described within the game context, and (b) contributed to the intrinsic integration of the game.

Consequently, the following four-level coding scheme was developed ad-hoc. In this scheme e stands for Element (i.e. game design element) and c stands for connection (i.e. relation between two game design elements).

[e/c]NP – e/c is not present in the DD

[e/c]MM – e/c is present but it needs major modifications

[e/c]SM – e/c is present but it needs some modifications

[e/c]NM – e/c is present and it needs minor or no modifications

To determine both the existence and the quality of relations between game elements, we decided to extract all relations (node links) appearing in the IGE-NAC model and break each connection down into several sub-connections. This resulted in a comprehensive list of direct connections (i.e. between elements). Each connection between any two nodes was explicitly defined as can be seen in table 2 below.

Table 1  
DEFINITION OF THE CONNECTIONS BETWEEN THE NODES

Node links	Definition of the connection
1. Narrative - Characters	1a. The narrative describes the characters 1b. The narrative describes the relation between characters 1c. The narrative describes the relation between characters, environment and goal
2. Narrative - Environment	2a. The narrative describes the environment 2b. The narrative is "happening" in an environment 2c. The narrative take place in a spatio-temporal setting
3. Characters - Hero	3. Characters include a hero
4. Hero - Resources	4. The hero uses resources
5. Resources - Obstacles	5. Resources are used to overcome obstacles
6. Resources - Content	6. Resources correlate to the content



Node links	Definition of the connection
7. Obstacles - Goal	7. Overcoming obstacles leads to goal
8. Mechanics - Resources	8. Mechanics describe the use of resources
9. Mechanics - Rules	9. Mechanics are bounded by the rules
10. Mechanics - Content	10. Mechanics lead to learning content
11. Mechanics - Obstacles	11. Mechanics relate to obstacles
12. Mechanics - Hero	12. Mechanics describe the hero's potential
13. Mechanics - Environment	13. Mechanics are bounded by the environment
14. Rules - Resources	14. Rules delimit the use of resources
15. Rules - Obstacles	15. Rules describe how to overcome obstacles
16. Rules - Goal	16a. Rules describe how to reach the goal 16b. Rules describe when the goal is reached
17. Rules - Character	17. Rules delimit the characters' role
18. Rules - Environment	18. Rules describe the environment restrictions

Using this coding scheme for elements and connections, the first author parsed all DDs and coded the presence of game elements (nodes) and their connections.

## 8 Results

The first two questions of this study examined the presence and quality of game elements in students' designs. The findings from the analysis are presented in Table 2. As the table shows, even though most of the game elements were present within the DDs, their quality was often inadequate.

Table 2  
PRESENCE AND QUALITY OF GAME ELEMENTS

Game Elements	Number of DDs				
	ENP Game element not present in the DD	Game element present in the DD			Totals
		EMM Major modifications needed	ESM Some modifications needed	ENM Minor or no modifications needed	
Narrative	1	13	15	5	34
Hero	1	11	16	6	34
Other characters	11	0	1	22	34
Environment	1	14	13	6	34
Content (learning)	0	26	8	0	34
Mechanics	1	21	10	2	34

Game Elements	Number of DDs				
	ENP Game element not present in the DD	Game element present in the DD			Totals
		EMM Major modifications needed	ESM Some modifications needed	ENM Minor or no modifications needed	
Resources	5	12	12	5	34
Rules	0	9	17	8	34
Obstacles	0	19	11	4	34
Game goal	0	12	7	15	34

### 8.1 Game elements not present (Case ENP)

The results show that most of the DDs were rather complete in terms of the basic game elements that were required. Starting with the most critical omissions, as can be seen in the table, 5 teams failed to introduce any Resources in their designs. This means that the hero was not explicitly provided with tools to reach the game goal. Furthermore, while one third of the DDs did not include Other characters, that might not be strictly required, depending on the game narrative.

### 8.2 Game elements that needed major modifications (Case EMM)

Regarding the most problematic game designs, Table 1 indicates problems with the quality of several of the game elements. It appears that the most challenging tasks for students concern the elements of Content and Mechanics in their DDs. The results also suggested that the following game elements: Obstacles, Environment, and Resources were also poorly addressed in a large number of DDs.

### 8.3 Game elements that needed some modifications (Case ESM)

Students appear to have handled better the incorporation of the Rules, Hero and Narrative game elements as these nodes needed only some alterations in order to be sufficiently described.

### 8.4 Game elements that needed minor or no modifications (Case ENM)

Finally, the game elements that were easily managed by the students and needed minor or no alterations, to fit the scenario perspective, were the Other characters and the Game goal elements.

The last two research questions focused on the presence and quality of the connections between game elements. The results are presented in Figure 2.

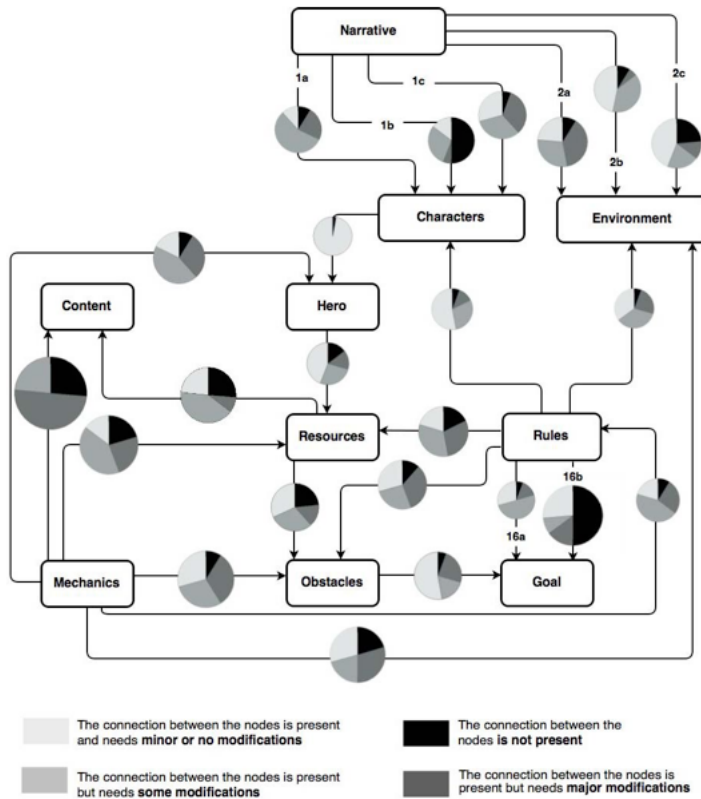


Fig. 2 - Presence and quality of connections between game elements

### 8.5 Connections between game elements not present (Case CNP)

The results showed that a very common omission in a number DDs was the absence of correlation between the game resources and the learning content of the game. Second, the findings also indicate a missing link regarding how the mechanics of the game could lead the player to content learning. Considering the centrality and the importance of these nodes for the IGENAC model, it appears that several DDs missed out the essence of SDG. Another common omission in the designs was that the relation between rules and conditions was poorly described, which made it unclear to determine the end state of the game.

### **8.6 Connections between game elements that needed major modifications (Case CMM)**

As figure 3 suggests, the students faced difficulties in forming satisfactory relations between the mechanics of the game and their relation to the learning content, and the obstacles of the game and their connection to the rules and the mechanics. This means that an association between game mechanics and learning was not evident in the DDs. While a connection was evident in the majority of the designs, it needed substantial revisions to reach a baseline acceptance level. The figure also shows that the DDs were characterized by a lack of appropriate connections between the game mechanics and the game obstacles, suggesting a poor description of how obstacles could be overcome. Finally, the narrative often lacked appropriate environment descriptions and involved insufficient depictions of the relation between the characters, the environment, and the game goal.

### **8.7 Connections between game elements that needed some modifications (Case CSM)**

Describing the resources within the mechanics did not pose any major difficulties to the students, who also managed to bind the mechanics with the use of rules relatively well. Furthermore, the DDs only needed some modifications when students explained how the resources correlate to the learning content and how the rules describe how to reach the game goal. Finally, the designs were relatively successful in describing the hero potential within the mechanics and the characters within their narrative.

### **8.8 Connections between game elements that needed minor or no modifications (Case CNM)**

The students in most cases formed adequate connections regarding how overcoming obstacles leads to the game goal and how the rules delimit the character's role and describe the environment restrictions. Furthermore, the students managed to provide their heroes with resources, even though overcoming these resources did not always lead to the game goal. Finally, the students managed to place their narrative within an environment and a spatio-temporal setting, providing their heroes with resources to use.

## **9 Discussion**

As it has been noted, the main challenge the field of SGD is currently facing relates to the disconnect between game design and educational design (Arnab *et*

*al.*, 2014; Bellotti *et al.*, 2012). To resolve this problem many researchers have proposed that domain experts and teachers should participate more actively in SGD (Charsky, 2010; Wouters *et al.*, 2011; Arnab *et al.*, 2013; 2014; Bellotti *et al.*, *op. cit.*; Mawas, 2014; Marne *et al.*, 2012). As teachers' pedagogical expertise on instructional design may or may not be readily transferable to game design, their experiences, perceptions, and approaches have not been systematically examined in actual game design tasks. The need to support novice designers in general and teachers in particular for SGD has been stressed (e.g. McMahon, 2009; van Rosmalen *et al.*, 2013). Despite calls for engaging teachers into SGD, there has been a paucity of corresponding published research. This work represents a first systematic attempt to map out the difficulties student teachers encounter in their first attempts to design an educational game.

The first two research questions focused on the quality of the designs in terms of the completeness of the game elements that were included in the designs. As the results showed, the students experienced major difficulties in integrating learning content into the game context and using appropriate mechanics to support learning. Furthermore, the students had trouble providing obstacles that could enhance the learning experience of the player and resources that could be utilized to overcome these obstacles within the game.

The last two research questions determined the quality of the designs in terms of presence and quality of connections between the game elements. The results indicated that about two thirds of the teams did not manage to associate mechanics to content, thereby producing insufficient designs. Furthermore, the complete absence of basic connections between various game elements on numerous occasions, for example relating resources to obstacles and resources to content, suggests that the student teachers experienced significant challenges in translating their expertise to game design.

This evidence clearly indicates that when novice designers, such as teachers, are engaged in designing games they face multiple problems. Regardless of their instructional and pedagogical expertise, the findings of the study suggest that student teachers struggled both in terms of using the most critical game design elements (i.e. mechanics, resources, and obstacles) and in combining them in meaningful ways so as to promote learning.

The findings of this study have important implications for SGD. First, Pedagogical expertise does not seem to translate directly into game design. It is obvious that merely introducing teachers to game design concepts, methods, techniques, and pipelines is not sufficient. While some teams made satisfactory game designs, the overall picture suggests that the designs fell short in terms of baseline quality. Consequently, the findings suggest that to induce teachers to the SGD process, systematic scaffolding is needed.

Second, considering that in some areas the designs were particularly lacking

quality-wise, the findings indicate for some specific areas of design scaffolding might be absolutely essential. More specifically, to address the unsuccessful incorporation of game elements and connections between them into the designs, existing design methods and models should be informed accordingly so as to provide a more structured learning path. For example, training curricula could be enriched with (a) paradigms of good and bad design practices and (b) collections of optimally designed SGs with their corresponding representations of game elements and connections.

## Conclusion

In this study student teachers were introduced to SGD and were asked to design an educational game. The analysis of the quality of their designs in terms of game elements and their interrelations indicated that, despite pedagogical expertise, the students struggled to incorporate the most critical game elements (mechanics, resources, and obstacles) into their designs. Moreover, they experienced major difficulties in connecting these game elements effectively so as to support learning. Solely introducing teachers to SGD does not seem to provide them with the requisite skills to produce acceptable designs. Future work should examine the reasons underlying such difficulties and explore systematic ways of scaffolding teachers in their early steps in SGD.

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