An Exploration of the Role of Feedback on Optimizing Teachers' Game Designs

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Abstract— Engaging learning experts in serious game design is one way of bridging the game design – educational design gap. This engagement is expected to lead to game designs of high educational value. However, conceptualizing how to involve experts in game design is still in very early stages. To address this issue, we examined the educational value of 24 serious game designs made by pre-service teachers. The findings suggest that, even after substantial support, the majority of the designs were found to be insufficient. The paper is concluded with a discussion of the findings and recommendations for further work.

***Index Terms*— Serious games design, Ideal design, Educational value, Learning experts**

I. Introduction

COMPUTER games have become increasingly popular over the past decades and have shown great potential in fostering the development of multiple skills. Serious Games (SGs) have recently emerged as a type of Computer Games that are designed to serve purposes other than pure entertainment [1]. Designing a SG is an interdisciplinary task requiring the cooperation between experts from different areas such as graphic design, product design, programming, animation, interactive design, writing, audio design, and content areas [2]. As [3], [4], [5] argue, the major problem that the Serious Games Design (SGD) field is currently facing concerns the disconnect between traditional game design and educational design. Recent conceptualizations recommend involving educators in the design process. It is being increasingly recognized that, to design effective serious games, the corresponding experts, content and instructional ones, would need to be actively involved in the design process [6]. [7]. Despite recent interest, few studies have focused on engaging teachers in the processes of game design (e.g. [8], [9]). Consequently, there is a knowledge gap regarding teacher engagement in serious game design. The present study aims to address this gap by reporting evidence from a systematic exploration of the content and forms of support that pre-service teachers require when they undertake game design tasks.

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II. Serious Games Design

A. Teachers and Game Design

While the design of a SG is an inherently interdisciplinary endeavour, it is only lately that the importance of cooperation between game designers and instructional designers has been consistently stressed [10], [11]. This cooperation premises the development of a common language, so that experts from various fields can communicate on the same grounds [10], [11], [3], [12].

The induction of educators to game design is a completely uncharted territory. The difficulties teachers might experience when they embark on game design are not known. Additionally, the content and form of the support that might be required to address these difficulties is also unknown. Although there is little published research on the topic, we will briefly review two studies the findings of which clearly illustrate the potential difficulties educators might face in designing games.

In the seminal [13] study, the game designs of 16 pre-service teachers were investigated. The authors reported that designing fraction games turned out to be very challenging for the teachers. As the initial designs lacked intrinsic integration and proper focus on user thinking, [13] introduced specific conceptual design tools to facilitate the improvement of the designs. The study concluded that the conceptual design tools provided were pivotal for making good game designs: it was only after the introduction of such tools that the game designs improved in a number of dimensions. In a more recent study involving a group of 9 university educators, [7] attempted to bridge the game development process and the story-writing process. The authors examined the uptake of a narrative tool built on the top of an educational game authoring platform (e-Adventure). The study findings indicate that, to understand the narrative tool and design games, the participants needed a particular form of scaffolding such as specific examples.

These findings suggest that, regardless of the subject matter, instructional, and learning expertise that teachers possess, facing difficulties in the course of game design is very likely. Documenting these difficulties and addressing them through support is essential for ensuring game design success. Both the

content and the form of this support needs to be systematically researched, as it might eventually be critical for successful game design. To facilitate teachers' encounters with the world of game design, two main components are required: (a) relevant conceptualizations, such as game design models, and (b) appropriate scaffolds such as worked out examples, structured guidance, and feedback.

In the remainder of this paper we report data from an on-going research project which aims to systematically investigate the content and form of support that educators might require when designing serious games. The paper is organized as follows. First, the design conceptualization (serious game design model) that was used in the study is briefly introduced. Second, the specific study context is described and the feedback scheme adopted is outlined. Finally, the paper is concluded with a discussion of the main study findings.

B. *A model for Serious Game Design*

In an attempt to bridge the gap between game design and educational design, a few SGD models have been advanced in recent years [5], [11], [3]. Depending on the perspective they take, these models fall along the traditional game design and educational design continuum. The authors have put forward, IGENAC, a holistic model for SG design [14], [15]. This model combines conventional game design elements (goal, obstacles, rules, mechanics) with narrative elements (characters, challenge, spatial environment, temporal environment) and academic content (intrinsic integration). The model is based on a specific conceptualization of learning that is derived from sociocultural theory. Drawing on the concept of mediation, the model enables the explicit association between game mechanics and learning mechanics. The model is comprised of 10 interrelated game elements (see Fig. 1).

The main idea behind IGENAC is that the player is bound to learn the embeded academic content by using appropriate resources to overcome specific obstacles. In terms of relations between game elements, an ideal game design will need to meet three main conditions simultaneously:

(a) the direct association among *Mechanics – Resources – Obstacles*. This relation is critical as it is through game mechanics that the player utilizes the resources provided to overcome the obstacles. In principle, the outcome of this utilization should be learning.

(b) the indirect association among *Resources – Learning Content*. Resolving the problems will require the player to use the resources appropriately. Again, it is through the game mechanics that the player accesses the resources, employing them as instruments. Consequently, the resources need to be instrumental for resolving the challenges and associated with the learning content.

(c) the indirect association among *Obstacles – Learning Content*. This indirect association describes the fact that to resolve the problem, the player will need to develop a body of concepts which, typically, coincide with the academic content ones.

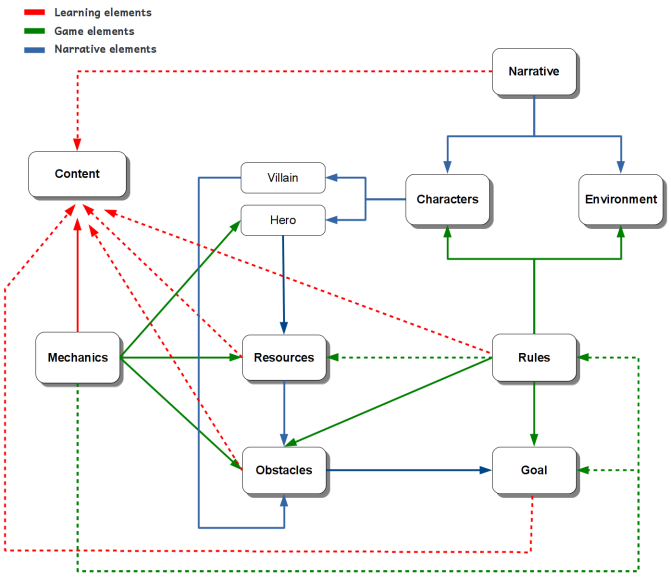

Fig. 1. The IGENAC model

The main premise of the present work is that good learning follows from good design [16]. Undoubtedly, a player can learn from a poorly designed SG, much like a player can learn from entertainment games [8]. However, such learning will be circumstantial at best, largely uncontrollable and unpredictable. Ensuring optimal learning from SGs through design requires leaving nothing to chance: the learning outcome should naturally follow from good design, being fully controllable and largely predictable.

Given a game design model such as IGENAC, one measure of game design quality is the extent to which it includes all elements and exhaustive relations amongst them. We will refer to such a complete design as an "ideal" one. In principle, such a high quality design would have the greatest educational value, namely the most potential for supporting learning. Conversely, the more a design diverges from the ideal one (i.e. it fails to include all game elements and encompasses only some associations between elements), the less educational value it has, considering that learning might occur but circumstantially, not necessarily as a consequence of systematic design. We argue that an ideal SG design includes all three types of aforementioned relations.

In the study reported in this paper we examine the designs novice game designers made after attending an undergraduate course on SGD. The aim of this course was to introduce pre-service teachers to the game design processes. Our intervention involved (a) the aforementioned IGENAC model as the main conceptual artifact, and (b) comprehensive feedback on the initial game designs. This feedback constituted an important part of the course and was meant to support student teachers in improving their initial designs. Our objective in this paper is to determine the quality of their revised designs by examining their nature and deviations from an ideal comprehensive design. The following question is addressed: *What is the quality of the revised game designs using "ideal designs" as a frame of reference*?

III. Method

A. Participants and Context

Seventy-five students participated in an undergraduate course on Serious Games Design and Development, offered at a preschool education department in a Greek state University. The course, that lasted 13 weeks, consisted of lectures and lab sessions. The students were introduced to the IGENAC model and, working in small teams of 2-3 members, (a) designed a SG and (b) developed a playable prototype. The 35 teams that were formed were asked to submit their initial designs in the form of a design document (DD). The idea was to provide feedback to the initial designs, finalize the designs and then proceed to the development of the prototype. After submission, the course teaching assistant (TA) (first author) reviewed all DDs and provided feedback via email to all teams. This feedback consisted of detailed comments and questions on the submitted designs. The feedback aimed to help students clarify or resolve potential ambiguities and/or misperceptions in their designs. In addition to annotated comments, optional face to face feedback sessions with the TA were also offered. In these sessions the TA and the team had the opportunity to discuss existing issues and students' new ideas for their design improvement. While such meetings were optional, they were highly recommended. Thirty four teams submitted valid initial DDs and 29 teams requested additional face to face meetings. Following the feedback phase, the students revised their DDs, and submitted their final designs along with a working game prototype. As 10 teams failed to submit a revised DD, the main data source of this study are the 24 revised DDs.

B. Measures and Analysis

The initial DDs have been analysed in a previous work [15] using the presence of game elements and the relations between them as criteria. The findings suggested that the students experienced major difficulties in associating mechanics to content, while various other connections (e.g. resources – obstacles, resources – learning content) between game elements were also missing. In this work we draw on the revised DDs in order to identify the quality of their designs.

Following previous work [15], we operationalized the educational value of each design in terms of the sequential connections that were present between game elements. The presence of a specific connection was defined in terms of its identifiable, discrete, and explicit appearance in each design. According to this operationalization, a game design is of high quality if the DD deviates minimally from the "ideal" design, i.e. no game design elements are missing and comprehensive associations between the elements are evident. Conversely, low design quality suggests omitted game elements and insufficient relation completeness.

IV. Results

Firstly, the sequential relations that appeared in the DDs were determined. As shown in Table I below, more than two thirds of the designs included appropriate connections between Mechanics – Resources – Obstacles. This means that in 7 of the designs either the obstacles were not associated with the resources provided or that the game mechanics were only indirectly related with the resources. Well over two thirds of the designs incorporated a proper connection between Resources – Learning content of the game. The remaining 7 designs, however, failed to associate the game resources with the learning of the academic content, thereby failing to meet one of the most critical objectives of SGs, i.e. learning. Finally, in the majority of the designs the obstacles were unrelated to the learning content, which suggests a fundamental flaw in most designs, as overcoming the obstacles was expected to lead to learning. Overall, these findings suggest that some of the designs were insufficient.

TABLE I
GROUPS OF RELATIONS IN DESIGNS

Relation(s)	Present	Not Present	Totals
Mechanics – Resources – Obstacles (A)	17	7	24
Resources – Learning Content (B)	17	7	24
Obstacles – Learning Content (C)	9	15	24

Furthermore, we identified the designs in which multiple sequential relations appeared simultaneously. The outcomes of this analysis are presented in Table II below.

TABLE II
RELATIONS COMPLETENESS

Relation(s)	Present	Not Present	Totals
(A) AND (B)	7		
(A) AND (C)	0		
(B) AND (C)	0	9	24
Ideal design: (A AND B) AND (A AND C) AND (B AND C)	8		

As table II suggests, only one third of the DDs corresponded to an ideal design, while almost one third only included two of the critical connections between game elements. Even though relations between two game element nodes were present in the students' designs, only a few designs were characterized by the

simultaneous presence of all the requisite relations. The students faced difficulties in forming all appropriate relations to the learning content of their designs which means that the resulting designs were not optimal in terms of educational value.

V. Discussion

To maximize the potential of SGs in the field of education, the focus needs to shift to their design. Traditional game design and educational design need to co-exist [3], [4], [5]. As designing SGs is an interdisciplinary task [2], to produce games with educational value, instructional designers' involvement is of essence [10], [11]. In the study reported in this paper instructional design experts were furnished with (a) a conceptual artifact (serious game design model) and (b) extensive feedback on their initial game designs. Overall, the study findings suggest that despite systematic support in terms of the IGENAC model and comprehensive feedback, only one third of the student teams managed to make game designs which would qualify as ideal.

It should be noted that our findings are consistent with contemporary research, confirming the inherent difficulties in designing SGs, such as combining the game design and the educational design approaches [3], [4], [5] and translating academic content into gaming tasks [17]. Furthermore, our findings are also in line with evidence from other studies (e.g. [13], [7]) which suggest that involving teachers into SGD might not be effective without support. While some of the pre-service teachers in our study made high quality designs, still the outcome cannot be considered satisfactory as two thirds of the student groups created suboptimal designs.

The contribution of the present study is that it sheds light on the SG design complexities that surfaced when the designers are educational experts, even if they (a) have a comprehensive conceptual design tool available, and (b) have received elaborate support through asynchronous and live feedback. Many sources [10], [11] advocate the importance of teacher participation in game design to bridge the traditional game design with educational design. However, the findings of this study suggest that (a) such participation is unlikely to be without challenges and (b) the content and form of the requisite support for resolving these challenges might be intricate.

Future research needs to be directed towards more systematic forms of both instruction and support in order to ensure game designs of sufficient quality.

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