

Designing a serious game as a tool for landscape and urban planning immersive learning

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Abstract. Urban and landscape planning are critical to ensure there is a right balance between three crucial dimensions: human development, societal welfare, and nature protection and conservation. These instruments play an important role during the Environmental Sciences studies and, when facing them, it is crucial for students to learn the importance of compromising between the above mentioned three dimensions to guarantee general progress. This paper presents the design process of a serious game (a tabletop game) that should provide an immersive learning experience to Environmental Sciences students, and raise their awareness about the complexity of the topic and the need to balance between human development, societal welfare, and nature protection and conservation. We will introduce in detail the inception process, the identification of the learning objectives and how these have driven the design of the game. We also present the initial evaluation performed during a piloting phase. Finally, we will draw initial conclusions and define further lines of research.

Keywords: Urban planning, Landscape planning, Games, Serious games.

1 Introduction

One of the greatest challenges the humanity is facing is how to ensure development and welfare [1] while, at the same time, preserving the natural values of the planet [2]. As any recurring *cliché*, this challenge may seem trivial and overtaken but it represents an important conundrum. All human activities affect nature, most of the times with negative effects on biodiversity and natural resources. In fact, environmental awareness has traditionally arisen when environmental problems appeared linked to certain levels of development. It is also recognized that nature conservation is not going to be a priority until certain levels of development and welfare is ensured to all people in a society. In fact, nowadays the concept of environment incorporates both human development and welfare together with the preservation of natural assets (e.g. biodiversity) [1, 2, 3].

All sort of societal instruments has been developed (in Western societies) to assist policies and decision making while mediating in the conflicts between nature conservation and human development: from administrative processes to planning and managing strategies. Landscape and urban planning are instruments in the category of prevention. They try to mediate in the underlying conflict before any human activity is deployed by planning human development, i.e., which and where activities are to be developed. The main objective is to use a territory in the most effective manner in order to optimize economical profits, human welfare and nature conservation.

Landscape planning is a complex process, in which multiple societal agents with confronting interests participate, coordinated by technicians and decision makers from public administrations. Public administrators should ideally coordinate the whole process by maintaining a neutral position, ensuring that the general interests are put forward. Landscape planning is a fundamental subject in Environmental Science studies [3], aiming to provide students with the necessary skills and tools to intervene in real-life situations. Our experience tells that most students have a strong bias towards nature conservation and sound conservation issues but have troubles to a) identify conflicts between development and nature conservation at more local scales, and b) to understand the importance of human development and welfare for itself but also for nature conservation. Hence, when case studies or examples are given to students, they mostly resolve them from that perspective, e.g., forbidding impacting activities (e.g. mining or gas extraction), or proposing unfeasible measures because of their economic impact. Providing students with an immersive experience should allow them to recognize the impact of the previous biases on landscape planning, which will result in students better equipped to face the challenges they will encounter as professionals.

Based on the foregoing motivation, we decided to develop a tool for immersive learning. The overall goal of the tool was to better introduce landscape and urban planning and related issues to students of Environmental Science, but also to raise awareness of its complexity to other people, e.g., high school students or decision makers. The main goal of this paper is to present the inception and development process of this learning tool. More specifically, this paper aims to: **Highlight how an immersive learning tool can be used to tackle existing learning issues; provide details on the design process**, in particular on satisfying the specific learning needs with specific features of the proposed learning tool; **discuss results obtained from a piloting phase** in which the learning tool has been evaluated; and **provide main conclusions and define future lines of work**.

2 Research questions and research approach

2.1 Research questions

Our main research question is defined as follows: “*Can an immersive learning tool let Environmental Sciences students experience the complex process of landscape planning?*”. This broad and open research question can be decomposed in more detailed research sub-questions, as follows: **1) RQ1: *What type of learning tool can achieve this and will, at the same time, guarantee a good learning experience?***; **2) RQ2: *If such a***

tool needs to be developed, how can we do this to ensure that the learning objectives are achieved?; and 3) RQ3: How can the learning tool be evaluated, before its general deployment in the educational context?

2.2 Research approach

Our research approach involved the following steps (and is in line with the Design Science Research methodology [4] aiming for creation of artifacts): **1) definition of the learning objectives**, which should act as the base for the objectives of the learning tool; **2) selection of the format of the learning tool** based on the learning objectives, available resources and timeframe; **3) definition of features** to ensure that the learning tool achieve the learning objectives; **4) design and initial prototyping**; **5) initial evaluation of the prototype** in a series of sessions to identify issues and opportunities of improvement; **6) improvements based on feedback** from the initial evaluation; and **7) further evaluation**. The last two steps of the process are to be conducted iteratively, in order to quickly and continuously improve the tool.

3 Definition of learning objectives and selection of tool format

Because interest and learning are stronger when based on experience [5,6], the main objective was formulated as follows: **let the students experience the situation of an environmentalist in the process of landscape planning and decision making in a local environment**. By doing so, we expect them to recognize the importance and complexity of the subject and to develop interest in the topic (e.g., at the beginning of a course). More specifically, we identified the following detailed learning objectives: 1) **Make the students aware of the importance and necessity of compromises** between human development, human welfare and nature conservation at levels they usually do not think of (local scales); 2) **ensure that the students experience the complexity of the decision-making process** in landscape planning when trying to balance human development, human welfare and nature conservation, especially in the context of limited economic resources; 3) **introduce situations about specific topics** (e.g., transport systems) that can be further discussed during the classes.

We opted for a game because when using games, the learning experience seems to be better [7]. A game can support our learning objectives as they provide students with an immersive, easy, and fun experience of the complexities of the subject. Among games, tabletop games are easy to learn and carry, and most human beings are used to play them [8]. Additionally, a board can easily represent geographical elements. Based on these arguments, our decision was to choose for a board game.

4 Related work

We conducted an initial search over IEEE and Google Scholar databases by using the following search strings: "learning games" AND ("urban planning" OR "natural environment") AND ("board games" OR "tabletop games").

There have been few attempts to introduce games as innovative learning tools in related fields (like natural environment, natural sciences, architecture, green building or environmental awareness) [8, 9, 10, 11, 12, 13, 14, 15] but there seem to be no existing game related to landscape planning. For instance, Marlow [9] identified existing digital games with potential to landscape architecture and environmental design education. Marlow presents and assesses the different existing games, but he does not present his own solution to the problem. In a different paper [10], Marlow presents how several computer-based games were designed as pilot projects in order to support landscape architecture teaching (which is different from landscape management), reporting good results. Juan and Chao [8] present a multi-player strategy board game to support the teaching of a green building strategy. Although the topic tackled is different from the one of our study, they give very interesting conclusions like the fact that the players have stronger learning motivation than the ones only attending the lectures and they have better learning outcomes. Similar to our approach, we found board games in the fields of urban sustainable development [11], energy simulation [12], and environmental and sustainability awareness [13, 14]. In all cases, board games are used as part of the learning process of environmental-related matters and seem to generate more interest from the students and give better results for those using these learning tools.

Overall, the previous papers suggest that using games, both computer-based and tabletop games, in related fields enhance the motivation of the students and improve the learning experience, helping to reach the learning objectives.

5 Design of the game

The definition of our board game features is based on the detailed learning objectives (section 3). Considering those and the peculiarities of landscape planning, we identified five main features that had to be present in the learning game: 1) Students need to **experience the decision-making process** and its conflicts; 2) **Decisions should be made in and affect a territory with its multiple aspects** (human activities deployed, impacts on natural assets, and human welfare and development, etc.); 3) **Decisions should be driven by individual interests** of various and potentially conflicting pressure groups; 4) Some **collective or public interest should apply** to force the students to balance between the individual interests of contrasting agents; 5) Some sort of **economic system should be used** to force all decisions being made in an environment with limited economic resources.

We opted to develop a multiplayer (3 to 5) tabletop game named “TERRITORY”, in which players play the role of decision makers subject to different interests when planning a territory. During the game, and by means of **action cards**, the players should decide how and when the territory should be developed, how the environment should be protected, and how industry and work-places should evolve. The fact of having several players represents the existence of several actors having different interests (conflicting or not). To simulate that decisions are often driven by individual interests, we introduced **individual goals** that the different players should pursue. These goals represent the main tasks of specific administrations or pressure groups lobbying decision

makers and they represent each player personal agenda. As real life decisions are not entirely made driven by personal agendas, we also incorporated aspects of public interest by means of **global goals** and **habitability tracks**. **Global goals** represent the common good or elements that benefit the whole (or a wide part of the) society and allow players to collaborate to achieve them. The need to collaborate in a global goal might not necessarily represent an altruist point of view. In that sense, it is a semi-collaborative game in which personal and global agendas should be wisely combined in order to succeed. On the other hand, **habitability tracks** measure the performance of the players in employing several elements defining the welfare of the territory: employment, services, and natural environment. They reflect the societal outcome of the individual players' actions and act as external constraints that force the players to reach a minimum amount of collaboration. Indeed, if habitability tracks decrease under a certain threshold, the outcome is a societal collapse, meaning that the game ends and all the players lose. This "lose-lose" scenario has the pedagogic goal of showing the consequences of an inefficient landscape management, in which the society fails and collapses. On the contrary, if players have done a good job compromising their personal agendas and lining them up with global goals, the habitability tracks increase. When habitability tracks reach a certain level, the game ends and points are distributed to find the winner. This is the one that managed to get the best balance between its individual goals, the global goals, and the habitability tracks.

Available economic resources are limited and depend on the current development status of the society. The players need to find a balance between allowing economic activities to increase their incomes and develop or protect the territory according to their individual/global goals. This aspect will make the players to propose realistic measures of development/protection, and they will be forced to balance between development and protection.

6 Evaluation and first results

6.1 Pilot Evaluations

We choose individuals without prior experience in landscape or urban planning as potential participants for the piloting phase of the game, intending to avoid any pre-conception towards the game based on pre-existing knowledge and to mimic, as much as possible, the situation of new students attending a course. We also did not require "gamers" profiles (individuals with strong gaming background) for participation, although we did not explicitly veto them, in order to make sure that we represent a normal (student) population, in which one will have, in general, a mix of people with different interest and background on games.

After a small introduction and playing the game, each participant in the piloting phase was asked to fill a questionnaire with 38 questions grouped in 6 sections: 1) game's topic and message, where we assess if the general subject is understood; 2) learning potential, where we try to evaluate if the participants see potential in the game as a learning tool; 3) learning experience, where we try to identify if we are reaching

the tool's objectives (e.g. Did the participants felt like decision makers? Did they experience the inherent conflicts of landscape managers?); 4) game experience, where we aim to evaluate the tool as a game (e.g. Is it easy? Fun?); 5) participant profile; 6) open feedback. Sections 2 to 4 used statements where the participants must manifest its level of agreement using a Likert scale [15] with values ranging from 1 (not at all) to 5 (extremely). All statements were affirmative and positive formulated, except for questions 3-5 in section 2 that were negative. Section 1, 5 and 6 were optional open questions.

So far, we have run two series of evaluations. Session 1 involved 12 participants, and took place in Brussels (Belgium), during July 2018 using the first version of the game. Session 2 involved 16 participants, taking place in Granada (Spain) during August 2018, and in Brussels (Belgium, during September 2018, using an improved version of the game based on feedback from Session 1.

6.2 Results

Participants of the evaluation sessions, who were instructed in the rules but received no information on the game's purpose or subject, defined the subject/theme of the game using words that clearly point towards environmental planning and management in which cooperation is crucial (Table 1). Fine-tuning of the game between the two sessions resulted in an increased recognition of collaboration and environmental aspects, while keeping the aspect of planning and management. Noteworthy, the number of words used in Session 2 to define the game decreased from 33 to 26, even though the number of participants was higher, suggesting that the changes resulted in improvements to understand the subject and issues of the immersive learning tool.

Table 1. Top-three keywords gathered to identify the game by participants in sessions 1 and 2.

Session 1		Session 2	
Keyword	Number of occurrences	Keyword	Number of occurrences
Planning/strategy	7	Collaboration/cooperation	10
Collaboration/cooperation	6	Environment	10
Environment	4	Management	7

All participants saw potential of the game as a learning tool and learned something by playing the game (Fig. 1: Section 2 and 3), and they were not missing knowledge to play, enjoy or learn (Q3-5). Results of sessions 1 and 2 were in general consistent, with a slight decrease on the amount of learning (Q1 and Q2) but also in the missing knowledge (Q3-5). This might point to the fact that we simplified some of the rules, making the game simpler to play but decreasing also the number of concepts that could be learned (Section 3). For the game experience, results were good (Fig. 1: Section 4), suggesting that the game is not monotonous or boring, provides a sense of satisfaction, is fun, challenging, but not too difficult.... More interestingly, the values for these characteristics increased in session 2. We can conclude that the simplification of the rules,

although it slightly reduced the learning experience, increased the game experience, making it also more enjoyable.

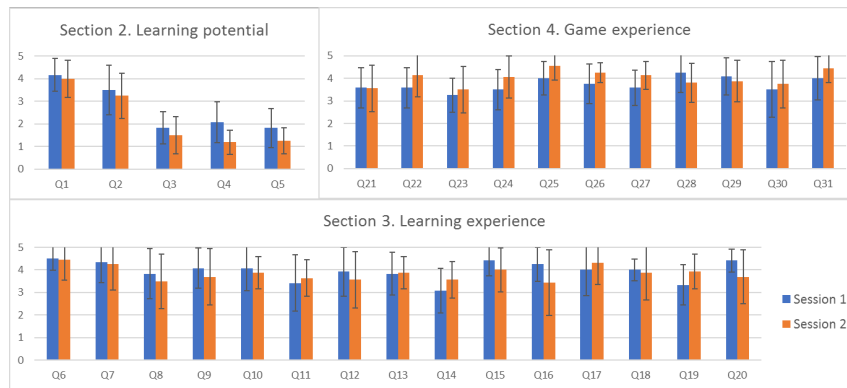


Fig. 1. Summary results with average (bars) and standard deviation (error bars) of Likert scale values in the questionnaires that were used in two sessions of initial evaluation.

7 Conclusions, limitations and future work

In this paper, we present the process of designing a tool to support the learning process in the context of urban and landscape planning. Starting from the main research question: “*Can a learning tool let Environmental Sciences students experience the complex process of landscape and urban planning?*”, we investigated three specific sub-questions and were able to provide the following answers: **RQ1:** Based on the identified learning objectives, the available resources and constraints, and the literature analysis, we have chosen a tabletop board game; **RQ2:** We have provided a systematic approach to the design of the learning tool by moving from the main learning goal to the learning objectives and next to the characteristics and features of the game; and **RQ3:** We have applied an iterative approach based on the creation of prototypes and performing evaluations with participants with a profile close to the profile of the target audience. This allowed for fast feedback and improvements of the game.

Our game seems to fulfill our main learning goal: it presents and lets the players experience the complexities of decision-making for the management of a landscape and its urban development. We have experienced that some compromises were needed between game experience and learning objectives. In order to obtain a good game experience (by keeping the game fun and engaging), we had to lower the ambition for the learning objectives. In that sense, the process of refining rules and testing them with real players was very useful to come to realistic objectives. The presented evaluations have, of course, limitations, as the number of participants was restricted. Furthermore, the participants were not students in Environmental Sciences, which makes it difficult to generalize and extrapolate. Also, there is certain subjectivity in the evaluation, as we were asking for the participants’ opinion. As further steps, we will introduce the game in official landscape/urban planning courses. It is very likely that this will result in a new round of fine-tuning. As part of the upcoming evaluations, we plan to include some

quantitative measures that could allow an objective assessment of the impact of the game in the learning process.

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