A NEW EDUTAINMENT TESTED TO RISE AWARENESS OF THE DANGERS OF SNOW AVALANCHES IN SUSCEPTIBLE SNOW ACTIVITIES
INTERNATIONAL SNOW SCIENCE WORKSHOP 2016 IN BRECKENRIDGE, CO

Luis G. López-Cobo*
Sage Entertainment, Andorra la Vella, Andorra

ABSTRACT: Raising awareness of snow avalanche danger has become a compulsory step when taking security measures, starting with potential mountain visitors. Since the process of increasing awareness is something that should start at a young age, an appealing, yet usable, layout is needed. There are no previous studies addressing the learning of the snow avalanche risks through games. Thus we had designed an educational board game of non-curricular knowledge, Riski Lavango. The game is intended for children, youngsters and novice adults, and it does not pursue technical learning concepts. Riski Lavango's requires no previous knowledge about avalanches. Just using intuition, observation and language, the player gets to learn the necessary safety skills when snow avalanches occur in winter mountain activities.

The process was conceived as an iterative system of invention-revision cycles. A survey was undertaken, comprising of questionnaires prior to and following playing of the game, participant observation, and personal interviews. We present here the results for playing one round. The first prototype has been well evaluated for motivation, playability, increase of interest, and self-perception of learning in danger of snow avalanches.

This experimental design let us develop some improvements on the prototype, affecting different aspects and leading to a suitable finished board game for raise the awareness against dangers of snow avalanches.

Riski Lavango could be considered an edutainment for formal, non-formal and informal learning from ten years old, in order to raise awareness of the dangers of snow avalanches, as well as a means of promoting snow activities. It’s a game customizable for different snow cultures and environments.

KEYWORDS: learning, board game, education, serious game, game design, educational game.

1. INTRODUCTION

The number of victims of mountain activities is increasing, given the increasing number of participants and disciplines. Snow avalanches are a major cause of accidents: snowmobiling, backcountry skiing, climbing, snowshoeing, Atkins (2010), Logan and Witmer (2012), Zweifel et al. (2012).

Awareness is regarded as an indispensable tool for taking action in risky situations and that should begin with the potential users of the mountain. Assuming that such awareness and social awareness should start in childhood, it is therefore necessary to create forms that are attractive and useful. Risk education should start at young age where education about natural hazards is performed through game activities, Komac et al. (2010).

Very much relevant to this, the comparison of formal and informal contexts of learning provides significant value to learning with games, Squire and Patterson (2009). It’s said that play is an essential strategy to stimulate the integral development of people in general. Playing to learn is equally applicable to traditional games and products in today's digital society, Marcano (2008).

There are many advocates for using leisure and serious games in schools and for vocational training (as well as domains outside of formal education) to enhance and support learning, Gee (2005), Smith (2006), Shaffer (2005), Ulicsak and Wright (2010).

We must move away from a view of education as a rite of passage involving the acquisition of sufficient knowledge and qualifications to acquire an adult station in life. The point of education should
not be to inculcate a body of knowledge, but to develop capabilities including the capacity to act responsibly in the case of natural hazards, to take initiative, and to work creatively and collaboratively. Education is seen less as knowledge acquisition but more as a series of processes through which knowledge, skills, values, and actions are acquired, Murdoch, (2004).

Michael and Chen (2009) suggest that compared to non-gamers, gamers have a deep understanding of risk versus reward and they are more able to take measured risks. There is a lack of studies on the effects of games on risk perception, Ulicsak and Wright (2010). And there are no previous studies found that analyze content learning through games related to avalanches. For that reason we have designed an educational board game of non-curricular knowledge, called Riski Lavango. Through playing the game, it encourages the practice of winter mountain activities and therefore raises awareness of the danger of avalanches and diffuse some values that reduce dangers. A similar example of a game is Riskland developed by UNISDR- UNICEF, UNISDR (2004).

Riski Lavango is aimed at children, adolescents and novice adults and is not intended as a pursuit of technical learning skills, but rather of learning values and skills or good practices. However, secondarily, it can inspire a certain amount of motivation in scientific learning, among the implementable learning objectives, according to National Research Council (2009), given the voluntary access options aimed at expanding knowledge. Some QR codes, included in the game, act as some informal science learning points.

Riski Lavango is an educational game that can be defined, except for its lack of video game technologies, as a serious game, an edutainment. Many of the qualities that make electronic games have great educational potential are also shared by card games and board games that are maybe deemed as older alternatives, but definitely not something that should be abandoned as inappropriate to new generations, Leme and Berlim (2012). In fact, sometimes the games are precursors of electronic games, Brathwaite and Schreiber (2009), Deterding (2010), Duarte (2012).

There is a growing acceptance amongst teachers that games have educational potential and there is an increasing willingness to use games in their classroom. Games provide a platform for active learning, where learning by doing have a higher average retention than seeing, hearing or from lectures, cited by Ulicsak and Wright (2010).

2. THEORETICAL FRAMEWORK

We have taken into consideration different theoretical aspects, here summarized. Some are of game design and of serious games. Serious games are the accepted term for games with an educational intent, Ulicsak and Wright (2010).

In our game design we sought to incorporate the principles of M. Csikszentmihalyi’s Theory of flow of positive psychology given its positive influence on learning in digital environments, Weilzman (2014). Similarly, it has also followed principles of J. Bruner’s Theory of instruction Martinez Salanova (1980). It aims to enable, sustain and give direction to our predisposition to exploring alternatives. The game has been developed in a way that does not require prior knowledge of avalanches. It uses intuitive learning, Casas Rodriguez (2013), observation and language, through which the player gets to know and learns the values that are needed for avalanche safety whilst participating in winter sports or leisure activities in the mountains. Also taken into account in the game design were aspects of Self-determination theory, intrinsic motivation is an important construct that reflects the natural human disposition to learn and assimilate, Ryan and Deci (2000).

The underlying pedagogies in the serious games define three generations of educational games, BinSubaih et al. (2009). The first is based heavily on behaviorism. Learning occurs through conditioning with the game element typically being a reward for the correct response to stimuli. These games are often called edutainment. Edutainment games tend to be based on tests, formats can include selective, subjective and others test games. This was followed by digital games based on cognitivism. In the third generation there are multiple models of learning: constructivism (explain it); experiential learning theory (learn by doing), Kolb’s learning cycle: (concrete learning, reflective observation, abstract conceptualization and active experimentation); situated learning (information used in context through a creation of a setting close to reality can easily be transferred to the real world); socio-cultural theory (discussion, reflection and analysis with learning facilitated by the culture and identity of the learner); and the full-learning cycle (initial understanding, test and the feedback results in a refined model).
According to Ulicsak and Wright (2010) the third generation games blend the conditional (the rules, etiquette, software or learning goals) with the experiential (the sense of play, agency, learning, improvisation and feedback). Thus in these games you know, or can determine, the goal but have the ability to identify and enact your preferences, exercise your own choice, and make mistakes. Successful games are a combination of potentially adaptive structures (such as rules), and the timely delivery of information. Both of these are relevant when teaching.

3. OBJECTIVES

In general terms the purpose of the study was to analyze the design of a prototype board game to be used in raising awareness of the dangers of avalanches in the practice of sports and leisure activities in snowy mountain conditions.

Specifically intended:

3.1 To analyze the worthiness of the prototype of the game to:
- Motivate interest towards gaining knowledge in the dangers of avalanches;
- Assess the prototype's playability and the acceptance of a similar game;
- Determine the efficiency of learning the values related to the prevention of such dangers.

3.2 Discover and implement improvements to it.

4. METHOD

The game design begins with shallow components that try to meet the objectives of the game being based on certain theories. Such components are elements, mechanical and dynamic, that need to be tested. The prototyping is creating a functional model of an idea, which allows testing of its applicability and the possibility of making improvements, Fullerton (2008). Ideally prototyping should follow an iterative process model. A test with a prototype is carried out, the improvements are identified in the concept or implementation, a new prototype is applied and the cycle restarts, Duarte (2012). The critical analysis of a game already has some theoretical development, considering the mechanics, dynamics and aesthetics, Hunicke et al. (2004); the rules, the game and the culture, Salen and Zimmerman (2004).

Initial prototype: dice, board, skills cards, danger cards, 100 virtual dice. The board (Fig. 1) is set up showing diagonally crossing paths between 4 mountains, which are identified by icons of different activities: snowmobile, helicopter, snowboard and touring ski. It has different squares within the paths for providing skills and danger cards. The mountains provide the opportunity to carry out test activities, which can be played if you attain sufficient requirements from a selection of skills and have amassed sufficient equipment.

Fig. 1: The board of initial prototype tested.

4.1 Design

The game design begins with shallow components that try to meet the objectives of the game being based on certain theories. Such components are elements, mechanical and dynamic, that need to be tested. The prototyping is creating a functional model of an idea, which allows testing of its applicability and the possibility of making improvements, Fullerton (2008). Ideally prototyping should follow an iterative process model. A test with a prototype is carried out, the improvements are identified in the concept or implementation, a new prototype is applied and the cycle restarts, Duarte (2012). The critical analysis of a game already has some theoretical development, considering the mechanics, dynamics and aesthetics, Hunicke et al. (2004); the rules, the game and the culture, Salen and Zimmerman (2004).
integrated within the game. Also, the learning objectives are aligned with the objectives of the game.

The game (first, initial prototype and then, definite or developed prototype) has been designed to correspond as much as possible to the principles of the teachings of Gee (2007): identity, interaction, production, risk taking, customization, agency, well organized problems, challenge and consolidation, opportunity and demand, located meanings, pleasant frustration, systemic thinking, exploration, lateral thinking and reformulation of objectives, intelligent tools and performance before competence.

According to the Theory of instruction, the game encourages exploration of alternatives, generating curiosity and expectation of reward and the uncertainty of the test result. The design promotes self-confidence. The fun components included in the game encourage a predisposition to replaying, which stimulates the willingness to learn in the long term.

The didactic structure comes from the literature, the values to be transferred to the players, inherent abilities for correct mountain practices in winter. The transmission codes were messages on the cards, the iconography of equipment for the disciplines and safety, meteorology, etc.

Sometimes the danger/reward cards bring together two antagonistic quanta. The game is designed at a unique level of intellectual development. The principle of advancement of the player in the game lies in the discovery, either by intuitive grasp or intuitive leap, as the mechanism of skill card selection is based on the selection of good messages or bad, with no prior knowledge required. With better knowledge on the subject, more often an intuitive leap is expected. The game has a built-in option of self-evaluation, at the moment that the player deduces the total score of their selected cards. This guides the player in the learning process, which leads to motivation. Motivated players may want to play at different times and in different places, overcoming barriers to learning both in formal or informal settings. The intrinsic reward felt inside the subject is more valuable.

Corrective knowledge is obtained in the post-game analysis. The best corrective knowledge should be noticeable in the conscious behaviors that the player will manifest in their attitudes to the preparation and real practices on the mountain. That corrective knowledge, once practiced in actual activities, acts as a renewed reward for the person.

According to the Theory of self-determining, in order to promote wellness and personal growth, the game should promote experiences and self-perception of autonomy, competence and relationship. The social connectivity is provided by the idiosyncrasies of the board game format, in addition to some dynamics that encourage interaction. Autonomy has been encouraged in the design when the choice is truly meaningful. This gives the player the perception that the fate of the game is in their hands. The player, through the experience of playing the game, feels that they are improving their ability to prevent accidents caused by avalanches in the practice of sports and leisure in the snow. They are accomplishing something by overcoming the activities and reaching the conclusion of the game: the command of the preventive skills and gaining awareness of the dangers of avalanches in such practices.

Intrinsically motivated behaviors tend to be more lingering over time, Villacorta et al. (2003), which make the game a more suitable tool for learning the values it contains.

More details about the design in López Cobo and Ribao (2015).

4.2 Test

The prototype was tested using a transverse experimental design in groups of between 2 and 6 players in different environments in Andorra: playgrounds, elementary school, high school, vocational training school, adults with no special relationship with the mountains, or specialists. The tests were conducted between December 2013 and September 2014. Players (n = 146) are aged 9 to 50 years. It has been tested in rooms with a maximum of four groups playing simultaneously. The activity tests were arbitrated by a non-player using a decoding table. For the analysis of results three different age groups have been created, from 9-11 years, 12 to 15 years and 16 years and older. Six surveys were removed due to lack of reliability. Analyses were performed on 140 surveys.

A survey was designed with objective questions, which was applied in two phases, one before and one after playing. Before playing, there is a first part of an anonymous group situation, a second part was self-perception of mountain experience and knowledge of the dangers of avalanches in mountain practices and a third part on knowledge. It consisted of four multiple-choice questions, each
with four possible answers. In the later stages the way the game had been played was evaluated and how to improve, finishing off with the same questions on knowledge that had been asked before playing. The evaluation asked about enjoyment, the fun factor, the willingness to play again, the recommendation and the reasons (fun, learning, entertainment, etc.), the perception of the game as an aid to learning, self-perception of the learning experience, how useful it had been in increasing interest in the dangers of avalanches, the quantitative assessment of the game and how to improve it. The prototype was tested mostly, 93%, in schools, playgrounds and workplaces. The rest was tested in private homes. To test the prototype in schools during school hours a previously agreed appointment was made. Most could only play once, 98%. Playing time ranged from 45 to 80 minutes, the more frequent time being 45 minutes. The data was analyzed with the program Gandia BarbWin 7.

5. RESULTS

5.1 Enhancements to the prototype

To make the game more educational and entertaining improvements have been made in the design and implementation of the game.

Design improvements:

- Diversification of significant squares.
- Increased relevance of basic safety equipment.
- An increased number of danger/reward cards: rewards and dynamics.
- Creating an individual score that shows progression and acts as feedback, score of achievement.
- Simplifying the text on the cards.
- The use of specialized typography: Open-dyslexic.
- The creation of links on certain cards to the web, providing information on avalanches. A QR code acts as a trigger; the landing page is related to the context of the card.
- Graphic design and illustration, example of box of the board game (Fig. 2). Example of the components (Fig. 3).

Enhancements in implementation:

- Two levels of difficulty.
- Hiding the value of the skills cards.
- Decoding with an application for mobiles.
- Adaptation of age and number of players.

Fig. 2: The box of Riski Lavango.

Fig. 3: The components of Riski Lavango.

The game now includes a board, 10 characters, a deck of skills cards and a deck of danger/rewards cards, 5 or 6 individual scoreboards, a dice and an application to download from the Internet in Play Store (Android) and App Store (IOS).

5.2 Survey results

This is a summary of the results; see López-Cobo and Ribao (2015).

Learning efficiency

The four multi-choice questions, made in the later stages of playing, to analyze the efficiency of the learning have a percentage of about 11% of responses unanswered (10.7 to 11.4%). The non-answers directly affect the experiment design and findings, skewing the study findings, without knowing in which direction or magnitude. The non-response is not distributed randomly, Clancy (2013). There are no conclusive results to allow us to speak objectively about the efficiency of learning attributed to the game.

However, we can analyze the evaluation questions regarding the self-perception of learning (Tbl. 1), and the self-perception of useful learning with the game (Tbl. 2).
Note: The relevant analysis of the significance of age classes, Pearson Jhi22, proves that both self-perceptions are two independent variables of age (significance = 0.004 and 0.001, respectively).

Tbl. 1: Self-perception of learning with the game

<table>
<thead>
<tr>
<th>Do you think the game helps you learn</th>
<th>Frequency</th>
<th>Percentages</th>
<th>Accumulated percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>140</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Yes, definitely</td>
<td>87</td>
<td>62.1</td>
<td>62.1</td>
</tr>
<tr>
<td>I’m not sure</td>
<td>36</td>
<td>25.7</td>
<td>87.9</td>
</tr>
<tr>
<td>No</td>
<td>8</td>
<td>5.7</td>
<td>93.6</td>
</tr>
<tr>
<td>No answer</td>
<td>9</td>
<td>6.4</td>
<td>100</td>
</tr>
</tbody>
</table>

Tbl. 2: Self-perception of have learned something useful

<table>
<thead>
<tr>
<th>You specifically think you’ve learned something useful</th>
<th>Frequency</th>
<th>Percentages</th>
<th>Accumulated percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>140</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Yes, definitely</td>
<td>81</td>
<td>57.9</td>
<td>57.9</td>
</tr>
<tr>
<td>I’m not sure</td>
<td>40</td>
<td>28.6</td>
<td>86.4</td>
</tr>
<tr>
<td>No</td>
<td>10</td>
<td>7.1</td>
<td>93.6</td>
</tr>
<tr>
<td>No answer</td>
<td>9</td>
<td>6.4</td>
<td>100</td>
</tr>
</tbody>
</table>

Learning with games offers the possibility of shifting the standard formats of assessment to consider other alternative dimensions of implementation and achievement, where the process has the priority over the content. In learning games mastery is not reached with the knowledge of manuals or textbooks, but with increasing familiarity with the system of choices and consequences. Some authors argue that focusing on how learners manage these choices can lead to a fairer assessment, Perrotta et al. (2013).

The assessment of the game could be informal, where the attitude and appreciation of others indicates achievement. Gee (2008) would choose to assess effectiveness by how the students are perceived after playing games.

Games are advocated as part of a blended learning process, and therefore the role of the teacher is essential, Felicia (2009).

Playability and acceptance of the prototype

There were more positive answers to the evaluation questions about: pleasing (60.00 %); fun (59.30 %); wanting to play again (63.60 %); recommendation (80.70 %); reason for recommendation: it’s fun (24.30 %), you learn (17.10 %), you learn whilst having fun (32.10 %), you have a good time (15.70 %); overall global rating: 7.79 over 10. All those variables were proved independent from age classes, Pearson Jhi22, (significance from 0.0000 to 0.0002).

When asked the question as to how to improve the game, those that responded have contributed a variety of ideas, the most common of which were:

- There is no reason to improve the prototype.
- They don’t know how to improve the prototype.
- To increase the number of mountains.
- Introduce more variety.
- Introduce boxes where you lose.
- Make it more fun.
- To use figurines.

The last four contributions have been corrected in the game.

Interest in learning the dangers of avalanches

Increase of interest’s player in the danger of snow avalanches, Tbl. 3.

Tbl. 3: Increase of interest’s player in the danger of snow avalanches

<table>
<thead>
<tr>
<th>Do you think the game increases your interest in the risks of avalanches</th>
<th>Frequency</th>
<th>Percentages</th>
<th>Accumulated percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>140</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Yes, a lot</td>
<td>47</td>
<td>33.6</td>
<td>33.6</td>
</tr>
<tr>
<td>Yes, quite a lot</td>
<td>35</td>
<td>25</td>
<td>58.6</td>
</tr>
<tr>
<td>Yes, a little</td>
<td>27</td>
<td>19.3</td>
<td>77.9</td>
</tr>
<tr>
<td>I don’t know</td>
<td>17</td>
<td>12.1</td>
<td>90</td>
</tr>
<tr>
<td>No, not at all</td>
<td>5</td>
<td>3.6</td>
<td>93.6</td>
</tr>
<tr>
<td>No answer</td>
<td>9</td>
<td>6.4</td>
<td>100</td>
</tr>
</tbody>
</table>

The relevant analysis of the significance of age classes, Pearson Jhi22, proves that they are two independent variables (significance = 0.004).

6. CONCLUSIONS AND FUTURE TRENDS

Testing the prototype has served as a pilot for its use in formal or informal education environments.

The initial prototype has been generally accepted regardless of age for the following concepts:

- Overall global rating, interest in wanting to play again, pleasing, fun, recommendation and percep-
tions of: help in learning, utility and increased interest in the dangers of avalanches. Intrinsic motivation of the players can be measured by the results of whether they voluntarily wanted to play the game again. Theoretically this is associated with social and cognitive development. This reinforces the hypothesis that the game promotes learning.

*Riski Lavango* could be an innovative edutainment of third generation upon the underlying pedagogy, both in formal, non-formal and in informal learning to raise awareness of the danger of avalanches while at the same time promoting some mountain activities, regardless of age, from 10 years old.

This game would be an independent learning experience for players, not dependent on a mentor. If involved, could increase the non-curricular knowledge of the game with their in-depth knowledge acquired. Or transversely with curricular knowledge, blending it to other disciplines such as social sciences, language and foreign languages, sciences, geography and environment, physical education, technology and perhaps others.

*Riski Lavango* presents no barriers of time or cost of platform to learn the game. After 15 minutes of play, the teacher captures how the game is related to the learning goals and the needs to be taken into account to sufficiently support learners if needed.

The game is customizable in language, sponsorship and QR codes that trigger learning from educational or training landing pages.

The use of the game might arouse interest in or complete other educational initiatives in schools, families and institutions. Its existence could have an influence on the generation of other awareness mechanisms, already initiated or new.

It’d be necessary to test the game further following the improved prototype to evaluate how the repetition of the game affects the players in their learning, taking into account an experimental design that involves keeping track of players individually. And that is carried out at least three times of playing, if not four. With individual monitoring of effective learning through playing, we might determine how the players gain knowledge and see the relationship in terms of self-perception of knowledge and experience. It may also be interesting to assess the players’ inclination according to the number of times they choose to play again. Consequently, we might identify the target population, i.e. What kind of people can benefit more from the game, according to the variables that would be measured: age classes, self-perception of experience in winter mountain practices and knowledge of the dangers of avalanches and perhaps others with a more local scope and context. Other trials could be to test the game in a school or extracurricular environment, either on an obligatory or voluntary basis and to analyze the differences.

Another trial would be to try to find corrective knowledge in the form of changes in attitude in mountain activities, where the player explores alternatives already explored in the game, after playing a significant number of times against a control group.

ACKNOWLEDGEMENTS

We would like to thank to all the people who have contributed to this research or the development of the game in some way (just to name a few):

First of all, thanks to those who have tested and improved the prototypes, specially to my daughters Lassa and Nayele, the playgrounds of the Parishes in Encamp and Canillo (Andorra), Angels Duró and Sergio Sánchez from the Vocational School of Aixovall (Andorra), and the Spanish schools from Andorra la Vella, Escaldes and Encamp (Andorra). To the graphic designer and illustrator Rayco Rodríguez for his creativity. To Sofía Venturino for her help with the prototype model. To the experts Sara Orgué from ACNA (Spain) and Francesc Poujarniscle (Putx) from EFPEM (Andorra), who validated the technical content of the cards. To the CRES - IEA (Andorra) experts team, who helped us with statistics. To Aina Marta and Òscar Santos from EDNA - IEA (Andorra), to ACNA (Spain), to Valenti Turu from Marcel Chevalier Foundation (Andorra), and Albert Rizzi from Nature Defense Association (ADN) of Andorra, for their support. To Rocio Hurtado from Snowthings, for her help with translations and for believing in this project from the very beginning. To Nuria Guerrero from SocialForest, and Tamara Morillas, for their help with translations. To Aurora López and to my beloved sister Azucena López, for their help as readers. To Sonsoles Valdivia for her help as reader and photographer, and for her friendly support. To Daniel Ribau and the Ministry of Education of the Spanish Embassy in Andorra, for facilitating the tests. To Steve Cummins and Josep Samarra for their help with translations, and with the development of the prototype, and for their amiable friendship and commitment. To Josep Tomàs and Joan López from RTVA for their help with Andorran media diffusion. Finally, to Ski Andorra and the Department of Cultural Promotion and Linguistic Policy, for their financial support.

REFERENCES
