PAPER

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Spies: an educational game

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Abstract

We present an educational game for teaching physics, *Spies*. The game is based on the popular boardgame *Codenames*. It is useful as a didactic tool to promote and improve student engagement. *Spies* is practical, fast and requires very little physical resources, which makes it ideal for high school teaching and viable in most diverse school realities.

1. Introduction

In recent decades, the world has experienced an unprecedented technological advance. It has never been easier to communicate, receive and send information, and stay connected to other people through social networks and the Internet. However, these changes have also brought new challenges and difficulties to the teaching-learning process. Pupils are dealing daily with an increasing amount of information and increasingly dynamic methods of communication. As a consequence, they show increasing resistance to the traditional teaching model. In fact, promoting and improving student engagement constitutes a great challenge for teaching now [1, 2]. In recent years many strategies have been proposed to promote and improve student engagement, among which, the use of games as educational and didactic tools [3–9].

Following this trend, we present *Spies*, an educational game based on a famous boardgame *Codenames*[3]. *Spies* is an entirely new game that may be used as a didactic tool for teaching physics. The game has some characteristics that make it an excellent educational tool.

It is simple as its rules may be learned easily and quickly. It is practical because it takes about twenty minutes or less to be played. Moreover, the game is adaptable to the most diverse school realities, and very few physical resources are required to play, namely only two computers with Internet access. In fact, the source code is available at the end of the text for those who do not have access to the Internet at school.

From an educational point of view, the game promotes and improves student engagement because it is, by design, dynamic and inclusive. All players must participate so the team may score in the game. The informality of the game also promotes engagement because students first play and then learn as a consequence of playing, which has already proved productive in promoting meaningful learning [9].

The game also promotes healthy competition between students, which may promote engagement [10]. Furthermore, *Spies* may be useful to evaluate if there is improvement in conceptual knowledge, which is fundamental to meaningful learning [11, 12]. Likewise, the game also stimulates logical reasoning, and the development of skills that may be applicable in different contexts, such as efficient verbal communication and the ability to work in groups.

[3] A good description of the game may be found at https://boardgamegeek.com/boardgame/178900/codenames

In the next section, we present the game and its rules. We then make some final comments.

2. The game *Spies*

Spies is a virtual game based on the classic and famous board game created by Vlaada Chvátil, *Codenames*. In *Spies*, two teams, red and blue, duel trying to score and avoid losing the game. The game may be accessed at https://girardi.blumenau.ufsc.br/spies_pictures/. Look figure 1.

To start the game, it is necessary to link two computers to the above address. In one of them, the player option must be chosen. In the other, the master option must be chosen. Next, players and masters should choose any number, the same number in both accesses. This number only selects the same set of images in both accesses. For example, if the chosen number is 234, the game boards for the players and the masters are shown, respectively, in figures 2(a) and (b).

Each team has one master, and at least one player, so that at least four people are required to play. The game board shows 25 pictures that are somehow related to physics concepts. In the master version of the board, each of the figures has a border in any of the following colors, red, blue, yellow or gray. The masters of each team may view the two game boards freely while the other players of the two teams may only view the player's game board, in which the figures appear without a colored border, as shown in figure 2(a). The master chooses an image whose border has the color of his team (blue or red). Next, the master names a concept of physics or a word from physics that, to best of his knowledge, is associated with the chosen image. The concept chosen by him is then informed to the other player of his team. The player has one minute to think, and select from his board the image that he thinks has been chosen by the master. A clock on the tray controls the time.

When the master or the player click on the figure once, the figure is enlarged and highlighted on the screen, as shown in figure 3(a). This allows the figure to be better visualized. The highlighted figure is definitely chosen with a second click in the player game board. If the border color of the chosen figure matches the color of team, the team scores a point; if the border color of the chosen figure matches the color of the other team, the opposing team scores one point; if the border color of the figure is orange, no team scores and finally if the border color of the chosen figure is gray, the team is summarily defeated. As the figures are chosen, their background takes on the color of their borders, as shown in figure 3(b). The teams play alternately. The game is won by the team that first finds all the images corresponding to its colour. The first team to play is shown at the top of the screen.

Some educational aspects of the game deserve to be mentioned. After the game is over, the teacher can mediate an interactive discussion with students in which masters and players will have the opportunity to justify their choices during the game. In general, no more than fifteen or twenty minutes are required for this with teams consisting of three students (one master and two players). Also during this time, it is possible to access the conceptual knowledge of the students in an informal and relaxed way, which it is fundamental for the promotion of meaningful learning [9]. This conversation is ideal for helping students develop oral communication skills, that are useful in both academic life and at work.

Details on the rules, and variations of the game can be accessed at http://games.paginas.ufsc.br.

3. Final remarks

We present an educational game that can support the physics teacher and help them promote and increase the engagement of their students in class, access the conceptual knowledge of their students and help them develop skills of wide application. As a didactic tool, the game is fast, practical and easily adjusts to most diverse school realities.

The game has been used by us on a number of occasions in different classes at Instituto Federal do Rio de Janeiro, campus Volta Redonda, Brazil, which allowed us to evaluate its adequacy to the curriculum, and the general objectives of the basic school. Finally, the source code of the game can be accessed at http://girardi.blumenau.ufsc.br/spies_pictures.tar.bz2. With this, new figures may be added and, in principle, the game could be modified to be used as a teaching tool in other

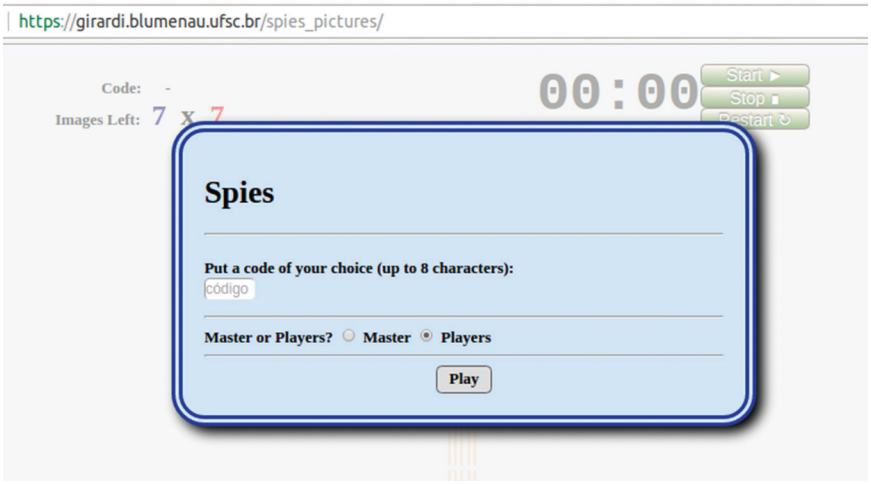

Figure 1. Game home screen appearance.

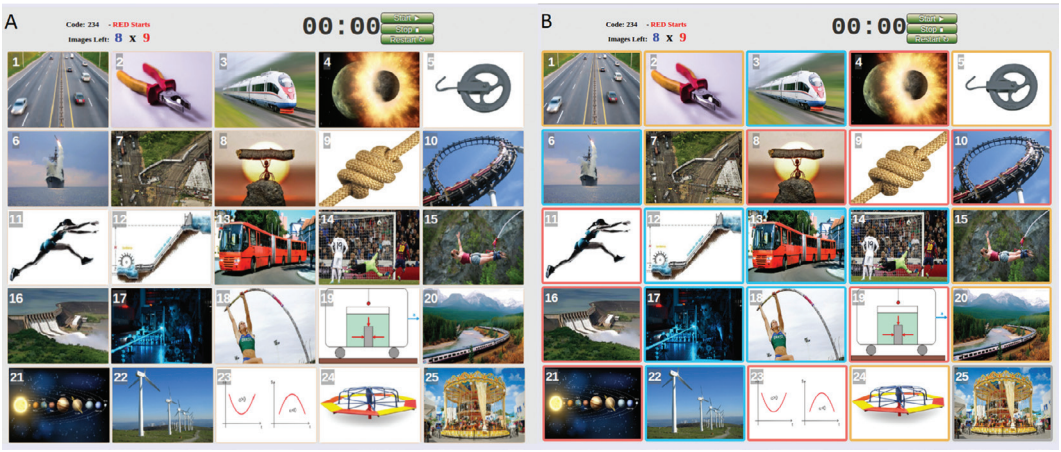

Figure 2. Player game board (a) and master game board (b).

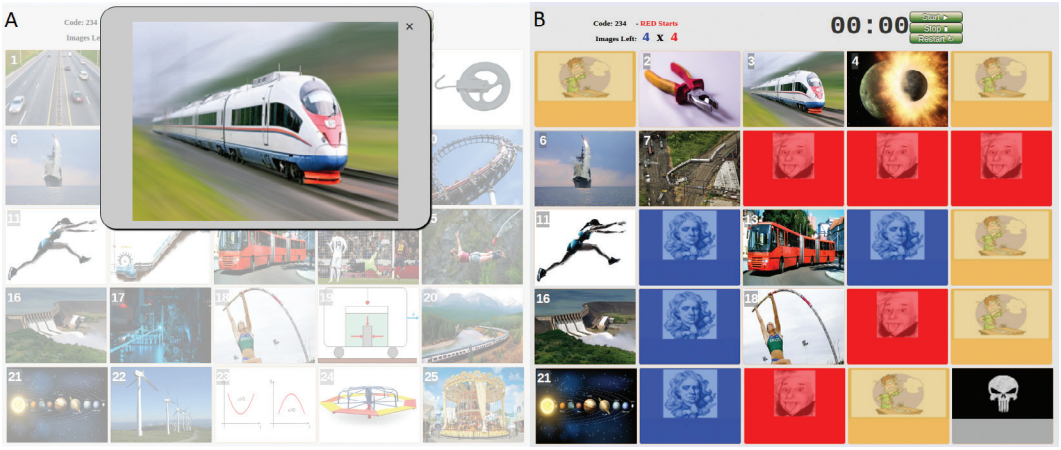

Figure 3. (a) Figure enlarged and highlighted on the screen. (b) The game board after some figures have already been chosen by the players.

disciplines, such as biology, history, geography, arts, etc.

For legal purposes, all images used in the game are free for non commercial purposes.

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References

[1] Prensky M R 2010 *Teaching Digital Natives: Partnering for Real Learning* (Thousand Oaks: Corwin Press)
[2] Butucha K G 2016 Emerging trends in student engagement in the 21st century contemporary world *Bar. Int. Res. J.* **6** 39
[3] Garris R, Ahlers R and Driskell J E 2002 Games, motivation, and learning: a research and practice model *Simul. Gaming* **33** 441–67
[4] Smith D R 2003 'Voyager': an educational card game *Phys. Edu.* **38** 47
[5] Price C B 2008 Learning physics with the unreal tournament engine *Phys. Edu.* **43** 291
[6] Smith D R and Munro E 2009 Educational card games *Phys. Edu.* **44** 479
[7] Rodrigues M and Carvalho P S 2013 Teaching physics with angry birds: exploring the kinematics and dynamics of the game *Phys. Edu.* **48** 431
[8] Rose J A, O'Meara J O, Gerhardt T C and Williams M 2016 Gamification: using elements of video games to improve engagement in an undergraduate physics class *Phys. Edu.* **51** 055007
[9] Croxton D and Kortemeyer G 2018 Informal physics learning from video games: a case study using gameplay videos *Phys. Edu.* **53** 015012
[10] Moll R F 2010 An amusement park physics competition *Phys. Edu.* **45** 362
[11] Yap K C and Wong C L 2017 Assessing conceptual learning from quantitative problem solving of a plane mirror problem *Phys. Edu.* **42** 50
[12] Haagen-Schützenhöfer C 2017 Students' conceptions on white light and implications for teaching and learning about colour *Phys. Edu.* **52** 044003

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