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Digital Games In Primary Classes

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Abstract

Introducing digital game play into primary schools may support the development and consolidation of some transversal skills in a way that is perceived by students as interesting and motivating. Spending a great effort in playing carefully selected games, may provide children with the possibility to acquire and exercise basic skills that are important for their future. A methodology for the organization of game based activities in primary classes to foster basic transversal skills is presented and results from its application aimed at logical thinking and spatial reasoning are reported. Results show a positive effect on students' school performance and on their learning attitudes and behaviour.

Introduction

The Italian National Guidelines for primary schools lists, among the learning objectives to be reached in mathematics, logical thinking (recognize and solve problems describing the used procedure and keep control of the process and results) and visuospatial abilities (recognize geometric figures when rotated, shifted or mirrored). These are basic transversal skills, closely correlated to students' school achievements in Science, Technology, Engineering, and Mathematics (STEM), and they may have also a positive impact on their future working life. However, these skills develop slowly and supporting actions need to last several years (King and Kitchener, 1994; Edwards, 2013). Even if it was suggested that digital games can be used in schools to foster learning (Vaegs et al., 2010), they are not frequently studied from the point of view of learning outcomes (Facer et al., 2007). The present paper presents a methodology for the organization of game based activities to facilitate the consolidation of basic skills, and results from its application in a primary school context. A wide spectrum of game types is currently available off-the-shelf, including role-plays, adventures, puzzle games, etc. These also feature a range of different strategies such as free exploration/navigation, question and answer routines, artefact making, etc. requiring players to enact different skills in order to be successful in the game.
When the games are carefully selected and used in a controlled manner, the great effort spent by children in playing may provide them the possibility to acquire and exercise at an early age transversal skills, which are considered crucial for a fruitful integration into the 21st Century digital world. However, an intensive and uncontrolled use of digital games can have negative impacts. According to Przybylski (2014), low levels of video game playing are associated with many benefits, both at a social and a personal level, but if the time spent on gaming exceeds a certain threshold these positive influences may diminish or disappear. Institute for Educational Technology of the Italian National Research Council established a line of research with the aim of investigating under which conditions playing selected off-the-shelf digital games could positively affect some basic transversal skill and, consequently, students' school success. A methodology was defined and tested, and results support the initial assumption: a positive impact on students' school performance and their learning attitudes and behaviour was found (Bottino et al., 2007; Bottino, Ott, and Tavella, 2011).

Digital entertainment games in formal education

When addressing education, "serious games" or "educational games" are often considered, this refers to games specifically built with an educational purpose. On the other hand, children spend a lot of time entertaining themselves with different games that have no specific educational aim. Nevertheless, playing with these games requires players to exercise specific skills and such skills can have a positive impact also on some school tasks. In our work, we considered the use of digital games that require the enactment of thinking and reasoning skills (i.e. games like puzzles or brainteasers), with the objective of defining, testing and refining a methodology for the selection and use of non-educational digital games in primary school classes aiming at the development of logical thinking and visuospatial abilities. The methodology, starting from a detailed analysis of the cognitive skills to be addressed, gives criteria for the selection of the games to be used and the organization of the intervention with a class. These include suggestions on the organization of the meetings and the needed tutoring support, guidelines on the ideal duration of the whole intervention as well as each play session and their frequency. Supporting materials such as monitoring sheets, management of game feedbacks, final appreciation questionnaires for students, etc. were also included. Moreover, general indications with respect to data that can be collected is given: observation sheets, interviews, game outcomes when available, as well as suggestions with respect to formal tests to measure students' performance.

A first study on reasoning abilities

The first study, involving four primary school classes in close cooperation with the class teachers, addressed the use of digital games to foster the development of logical thinking abilities (Bottino et al., 2014). Results from this study were then used to refine the methodology and devise specific teacher guidelines. Furthermore, the possibility to modify existing games making them more adaptable to the needs of learners was also investigated.

Game Selection

In order to choose the games to be used, a first analysis of the main abilities to be considered was carried out. The following elements were identified:

- know the rules of the game and apply them in real game plays;
• make an inference based on the available information in a certain moment of the game and/or on constraints given by the game;
• evaluate if the available information at a certain time is enough to decide whether a move or a configuration is correct;
• be able to combine previous reasoning to complete a schema in the game.

In the study, we focused on single player puzzle games, which, according to the game taxonomy presented by Gunn, Craenen, and Hart (2009), are small games that can be completed by using logical and reasoning skills to reach the goals. Games were selected primarily according to the skills they enact for their solutions, as well as other characteristics: the average time needed to complete a game session, the availability of different versions (single vs. multi player, aesthetics, etc.) and difficulty levels, the possibility to keep track of the player moves, the given feedback, etc. Game accessibility and costs, and the needed technological support were also considered. Most of the selected games run on Android tablets, and could be freely downloaded from the web.

Methodology and Results

The study involved four different classes of the last years of primary school. Students played once a week with the selected games for three months with the support of their class teacher and some researchers. All students showed a high interest and participation during game sessions and the experiment had a positive impact on the class climate. Qualitative data was collected both from direct observations, final questionnaires and interviews with the students. Moreover, results from a national assessment test were analysed and the experimental classes scored on average better than the other classes of the same school (Bottino et al., 2007). One of the main outcomes of this study points to the students' need for a close tutoring to help and guide their reasoning, fostering the application of deductive thinking rather than a trial-and-error approach to solve the given problem. In order to maximize the effect, the feedback offered by the games should be considered during game selection, and peer support during game play has proved to be very valuable. The possibility to adapt existing games enhancing their feedbacks to make the players more independent from their tutors is still under investigation. An open source version of the classic Master Mind game was modified to include the possibility to trace the players moves and to give a personalized feedback based on the game play (Bottino, Ott and Benigno, 2009).

A second study on visuospatial abilities

The methodology was then revised, teacher guidelines were created and then tested in a second study focused on fostering visuospatial abilities in students of the last two years of primary school (Freina et al., 2017). Visuospatial abilities include several different skills and there is no unique definition in literature. Nevertheless, all authors agree in including two main elements:

• the ability to imagine a two or three dimensional object in space and understand how it changes when moved, rotated, reflected or stretched,
• and the ability to understand positions in space, recognize the relative position of a set of objects, and understand what it would look like from a different point of view.
Several studies demonstrated that there is a close correlation between visuospatial abilities and achievements in STEM related subjects (Newcombe, 2010). Other studies showed that these abilities can be improved with a specific training and such an improvement is transferred to different contexts and lasts in time (Uttal et al., 2013). Consequently, a game-based training of visuospatial abilities in primary students was organized and its impact on school results in mathematics was measured using a standardized math test.

**Preliminary Study**

As the addressed skills were analysed, the strong embodied characteristics of visuospatial abilities emerged. A preliminary study was thus organized to assess the impact of immersion in a virtual world on the enactment of these abilities. The digital game "In Your Eyes", focused on Visual Perspective Taking: the ability to understand how a given scene would look like from the point of view of another person, was developed. The game takes place in a virtual living room, with a table in the middle and some objects on it. Four screens on the wall show the pictures of the table from the four sides. A virtual non-player character moves to one side of the table, and then asks the player to select the picture showing the table as he (the non-player character) sees it. The player can move in the room but has to go to a defined play position to answer. The game is available in a complete immersive version (which uses a Head Mounted Display), a semi-immersive version where the virtual world is seen through the computer screen, and a non-immersive version in which the player has only a fixed view of the room and cannot move. "In Your Eyes" was tested with a limited number of students to measure the impact of the different levels of immersion on performance in the game. Even though statistics showed a slight difference in scores in favour of the immersive version, such a difference was not significant (Freina et al., 2017). These results, the costs and limited availability of the Head Mounted Display, and some motion sickness experienced by a few students, made us decide not to use immersive games in the study. Thus, all the chosen games were either on tablets or standard computers.

**Methodology and Results**

Freina, Bottino and Ferlino (2018a) report the outcomes of the application of the methodology in two classes in the last years of an Italian primary school. In the initial analysis of the visuospatial abilities, the following components were selected: visual memory, visuo-motor coordination, the ability to imagine a bi- or three dimensional shape, the ability to understand what three dimensional object results from folding a two dimensional shape, finding strategies for filling an area or a volume, and orienting oneself in space. Based on these, a wide set of games was analysed and selected. Each meeting focused on one of the previously mentioned components, and several games were offered to the students, allowing them to choose freely according to their interests and abilities. A complete set of monitoring tools was defined, including observation sheets, questionnaires and interviews. A standardized math test was chosen to measure the students’ mathematical achievements in the most consistent manner across different classes (Cornoldi et al., 2012). The test was given before the start of the training sessions and at the end of the project. Data analysis showed that those classes that followed the game session performed statistically better at the standardized math post-test when compared to control classes that followed the traditional curriculum only (Freina et al., 2017). All the involved students were enthusiastic of the game activities and participated with great commitment, even though with large differences both with respect to the kinds of games they chose and the level of difficulty they could reach.
Nevertheless, it was noticed that the involvement and interest were generally higher in those activities that required a more active and creative participation from the children.

Conclusion

Our research studies highlight the pedagogical potential of puzzle games to support and foster problem solving, reasoning skills and visual spatial abilities, showing that their use under certain conditions may have a positive impact on school performance in curricular subjects such as mathematics. The experience gained in such studies, supports the assumption that early and appropriately designed interventions focused on transversal skills carried out through game-based activities can positively affect students' school performance as well as students' learning attitudes and behaviour. Some elements still need a deeper study. For example, results show that students improve better their play strategies when they receive personalized support. This may be achieved through an adaptation of the games to be used, enriching them with specific feedback. Due to the students' high interest for all the activities that allowed them to be more active and creative, the focus of the following experiments was widened to include game making activities. Game making can be a very valuable educational activity, able to trigger students' transversal skills, such as reasoning abilities, creative attitudes and computational thinking skills (Bottino and Chiocciariello, 2015). Kafai and Burke (2016) argued that student-designed games can teach not only programming but also academic subjects and transversal basic skills such as collaboration and teamwork. However, they do not suggest a shift to game making from game playing but rather argue for a more comprehensive, inclusive idea of game use in education in which both making and playing should be considered. Specific environments to support game making activities are available and there is an increasing interest in their educational use. Since a long time period, spanning over all the primary grades, is needed to allow students to gain the needed experience and increase their coding abilities, after a first definition of a learning path supporting CT in primary school (Freina et al., 2018b), a long term study is currently being carried out spanning from grades 3 to 5 of a primary school. Data is being collected with respect to every student showing their gradual improvement in coding and will be analysed at the end of every school year.

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Player Identity Construction And Co-construction In Counter Strike: Global Offensive Within An Educational Context

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