Supporting the development of Spatial Intelligence through Serious Games

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Introduction
Contemporary education is strongly focused on the development of those horizontal, cross-disciplinary, often not subject-based competences that are also called “transversal” or “key” skills. A number of academic studies support the idea that they are high-effectual educational tools (Robertson & Miller, 2009) and, recently, EU (Vassiliou, 2011) has also pointed out the actual potential of these tools to sustain a variety of cognitive abilities that are regarded as “crucial transversal competences” necessarily needed nowadays to live and be active actors in the Knowledge Society.

In particular, Serious games (SGs) are considered high potential tools in this respect, because they offer realistic and compelling challenges, highly stimulate information processing capabilities and are able to enhance motivation and capture concentration for long duration (Ott & Tavella, 2009).

Many authors recognize that the educational use of digital games has a significant impact on students’ cognitive skills (ranging from hours to a few weeks), have improved their skills – sometimes with very encouraging results (Newcombe et al., 2012), but few deal with their adoption for supporting spatial abilities, which nevertheless are to be considered important transversal skills (Sarno, 2012) since people use this form of reasoning in many everyday activities, ranging from organizing a room to driving a car.

In this study, we concentrate on the impact of SGS on the development of Spatial Intelligence, one of the nine types of intelligence mentioned in the theory of multiple intelligences (Gardner, 1983) and present an ad hoc developed Serious Game called SMART VIEW.

Spatial Intelligence and its relevance from an educational viewpoint
Spatial Intelligence involves the ability to make spatial judgments and correctly define the reciprocal position of different objects in the environment; it is strictly linked to the ability of visualizing shapes in our “mind’s eye”. Gardner defines it as a human computational capacity that provides the ability or mental skill to solve spatial problems of navigation, visualization of objects from different angles and/or to notice fine details.

Spatial intelligence deals with interpreting and making judgements about the shape, size, movement, and relationships between surrounding objects, as well as the ability to envision and manipulate 3D models. It allows somebody to know where exactly he or she is located in relation to other objects or places, and heavily influences a person’s ability to interpret and follow a map; it also involves the ability to anticipate the path and speed of moving objects, as it is necessary when crossing a busy street or catching a ball while playing baseball or tennis.

The capacity to retain the form of something in the mind's eye and picture it from different perspectives is key to this type of intelligence. Those who have strong spatial perception are likely to enjoy art, rarely get lost, imagine things very vividly, use metaphors, and "look at the big picture" when solving problems. These people are often referred to as visual learners, and they often possess "photographic" memories, retaining images more easily than words or numbers.

From a strictly educational viewpoint, Newcombe and Frick (2010) found that children and adolescents who have higher spatial skills in middle and high school are more likely to well perform in the STEM disciplines (Science, Technology, Engineering, and Mathematics) in college and to pursue STEM careers later on. Those who score well in this area usually also succeed in arts fields, as well as some sports.

But… can spatial intelligence be improved? Relevant and recent scientific studies strongly suggest that people can improve their spatial skills with training. In a variety of experiments, adults and children, after a short training period (ranging from hours to a few weeks), have improved their skills – sometimes with very encouraging results (Newcombe and Frick, 2010).

Sustaining the development of Spatial Intelligence by means of the SMART VIEW Game
Considering the relevance of spatial intelligence and the relatively scarce number of educational tools in this area, we got the idea to develop an educational Serious Game facilitating the emergence, the support and the fostering of the spatial intelligence abilities in young children, even in preschool age.

The developed game, called SMART VIEW is a Serious Game, focusing on early spatial skills development and aims to train the mastering and consolidation of competences related to space awareness and self-perception in the space. In particular, it aims to train those visuo-spatial abilities that allow an individual to execute an embodied self-rotation, through which s/he can actively imagine her/himself assuming different positions in the environment so to better allow mobility in unknown physical environments and to enhance the ability of “reading” and “self-localising” in existing maps.

As a matter of fact, SMART VIEW exercises particularly the following skills: the visual perspective-taking (VPT) and the mental rotation (MR).

VPT is the ability to put ourselves into the shoes of another: the ability to non-ego-centrically represent the aspects of the world around. The VPT ability is related to the visual-spatial experiences of an individual, and involves a relationship based on if and how other people see an object or a relationship based on the relative spatial locations of the other
people and the object. In both cases, the ability to identify the position and the orientation of someone else and the ability to understand that their perspective may be different from our own (Surtees et al., 2013a; Surtees et al., 2013b) is required.

In the game, the subject is in front of a touchscreen table, free to move around it, and observes a virtual scene of a table, as if they were sitting on a chair. Different objects can be presented on the table, whose number varies, from a minimum of 1 to a maximum of 3, according to the difficulty level reached or selected by the tutor. One of the game exercises is aimed at training the VPT ability i.e. it aims at consolidating the awareness/knowledge that people in different positions around the table see the same object/s differently. The user is asked to define what he sees from his actual position and subsequently he is asked to define what another one can see from a different position: actually he has to make a judgement about the other one’s perspective/view of the same object. The user is instructed to click the image that matches the objects view that he thinks the other would see from his new location (Fig.1).

As to the Mental Rotation, it is a particular aspect of a more complex cognitive skill: the visual mental imagery, the ability to see with the mind’s eye. It is defined as the ability to mental rotate two or three-dimensional figure rapidly and accurately and to imagine the aspect of the figure after it was rotated around an axes with a certain number of degrees. Mental rotation is the process of transforming the mental image of a three-dimensional object to represent the same object as if seen from a different point of view.

The game presents one image representing the scene view taken from a specific position, while the main scene presents the virtual table rotated by a random angle. The participant is then asked to rotate the virtual table in the main scene until the perspective of the objects, as they appear, does not match what he thinks he should see from his actual position (Fig. 2).

Future work
The SMARTVIEW game is now being tested with final users of different ages and with different personal characteristics. Detailed results of ongoing field experiments will be soon available, that will provide food for thoughts and will hopefully also support with concrete data the idea that SGs can be profitably used for supporting Spatial Intelligence development and/or enhancement.

REFERENCES