Chapter 7
PotenziaMente:
A Collection of Online Games for Learning Mathematics and Enhance Thought Processes

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ABSTRACT

Starting from the diffusion of information technology in schools, many computer games have been produced for the teaching and learning of mathematics. Most of these adopt a teaching approach that repurposes school situations embedded in game situations. The software object of the experiment described in this chapter was in fact to adopt a different approach. It proposes a series of games inspired to real-world situations in which the student must evolve a wide range of cognitive functions and mathematical contents. The games were constructed in line with objectives outlined by the Italian National Guidelines for the Curriculum (2007). The student perceives the interaction as a pure game interaction, but the effect is to increase their knowledge, skills, and competencies in mathematics, in addition to exercising a wide range of cognitive functions.

INTRODUCTION

Is it possible to learn mathematics, languages, science playing with the computer? Play with your computer (or console) makes you more "intelligent"? What are the processes of thought that videogames help to develop? This article describes the design of software to facilitate learning in mathematics and an experiment of the software prototype in a primary school. The software (called PotenziaMente and freely available at www.edurete.org/PotenziaMente) offer several games designed to exercise the thought processes of children in primary school, in order to accomplish the learning objectives described from the Guidelines for the Curriculum of the Italian Ministry of Education (September 2007) in Mathematics and Italian language.

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The software was designed and implemented by the author at Department of Philosophy and Education, University of Turin (Italy). It was developed within the activities of the Fenix project, conceived and coordinated by Cristina Coggi (Coggi, 2009, see www.edurete.org).

The experiment was performed at the primary private school "Mary Immaculate", a catholic school in Pinerolo, a small city of about 30,000 people in the province of Turin (Italy). A third class of 27 children was involved. Each child in the sample has attended a minimum of one to a maximum of three games sessions.

General aim of the PotenziaMente project is designing and implementing an effective software solution to facilitate learning of mathematics in primary school and to motivate pupils to learn.

Aim of the experiment is to test the effectiveness of the software prototype in a real-world learning context.

Learning outcomes have been monitored evaluating the difference of performances from an initial test (before of the learning activity involving the software) and a final test (after the learning activity). Protocols are available at www.edurete.org/PotenziaMente.

On-field work has been carried out by Dr. Chiara Bertolino in her final thesis for the bachelor's degree in Science of Education, from October to November 2010.

BACKGROUND

As reported by John Hattie (2009) in his synthesis of meta-analysis about student achievement, there are factors that seem to have noticeable impact on learning outcomes. For the mathematics, the relationship between the Piagetian stage (logical operations, concrete, formal-operational) and achievement is very high (effect size d=1.28). The ability of perform basic logical operation (e.g. seriation ability, that is put in order a set of objects according to a property) is highly correlate with achievement. Knowing the ways in which the children think is very important to design effective instruction supported by technologies (Sweller, 2008) and working to enhance the basic cognitive ability is a way to improve scholastic achievement (Feuerstein, Rand, Rynders, 1988). Basic cognitive ability is involved in many scholastic activities, and good didactics and evaluation must take in account they (Anderson & Krathwohl, 2001).

Another noticeable factor impacting on achievement is feedback. The power of feedback to support student in learning mathematics was highlighted by Baker, Gersten and Lee (2002). They found that the highest effects accrued when teachers provided feedback data or recommendation to student (effect size d=0.71), then for peer-assisted learning (d=0.62), explicit teacher-led instruction (d=0.65), direct instruction (d=0.65), and concrete feedback to parents (d=0.43). As they noted, one consistent finding was that providing teachers and students with specific information about how each student was performing (in the task proposed) seemed to enhance mathematics achievement consistently.

An effective feedback is a bidirectional feedback. Hattie (2009) emphasizes the importance for the teacher of obtain feedback from the students about what they know, what they understand, where they make errors, when e where they have misconceptions, when they are not engaged, in order to "synchronize" teaching and learning (effect size d=0.73).

Presenting concepts in according to Piagetian principles and give persistent and articulate feedback to the pupil - aiding also the pupils to give feedback about their learning to the teacher -, seems to be an effective strategy to teach mathematics in primary school. These principles can