

## **Educational game *Euro-Axio-Polis*: Mathematics, economic crisis and sustainability**

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A game called Euro-Axio-Polis was constructed by students of the Aegean University aiming to promote teaching and learning on mathematics and sustainability for 6th grade pupils. 40 students played Euro-Axio-Polis and Monopoly to investigate differences between the two games, and wrote five key words that characterized each game. Also 19 sixth grade pupils played the Euro-Axio-Polis game during students' teaching practice and wrote five key words about the game. The research results suggest that Monopoly reflects capitalist economic terms and social values while Euro-Axio-Polis reflects social values associated with sustainable development such as solidarity and equity. Pupils were more likely than students to make reference to socio-political issues such as parliament, education, democracy, elections and political power. As far as mathematics is concerned, most students and half of 6th grade pupils recall the mathematical concepts percentages and interest rates while they played Euro-Axio-Polis.

**Keywords: teacher training, cross thematic teaching approaches, mathematics, sustainability and values**

### **Overview**

Research in mathematics education and training over the last decades has focused on the enhancement of new pedagogical and epistemological approaches to learning and teaching mathematics. However, the shift from the positivist paradigm about mathematics as well as from the teacher-centered instructional models towards constructivist and emancipatory ones is a challenging task for many mathematics education students. It is difficult for them to understand, for example, how mathematics is related to cultural issues and ideas that may affect peoples' everyday lives (Burton 2004; Chasapis 1996) and what is the meaning of contextual and authentic learning in mathematics education (Lave and Wenger 1991). As is the case for facilitation of pupils' mathematical learning, trainee teachers may also learn better by doing, i.e., designing and exploring new approaches to teaching and learning in a collaborative context, developing some novel learning activities, experimenting and reflecting critically on them, and transforming their own new mathematical discourse as well as their instructional schemas. By doing so students are also beginning to learn a) how to relate theory with practice in mathematics education (Jaworski 2006; Sakonidis 2012; Rowland et al. 2012; Lerman, Murphy and Winbourne 2012); b) how to deal with complexity while creating and managing meaningful and flexible learning environment (Potari and Jaworski 2002); c) how to realize critical epistemological concepts, such as Leone's Burton "four epistemological challenges" (2004) to mathematics education.

Having adopted most of the above dimensions of pedagogical philosophy, the formal Curriculum Development Design for Mathematics, introduced by the Greek Ministry of Education (Pedagogical Institute 2003), has given emphasis, among others, on a) the implementation of some inter-disciplinary and cross-thematic (Chionidou-Moskofoglou 2007) projects within all school subjects; b) the provision of extra time for a “Flexible Zone” type of instruction during which open and innovative approaches to learning and teaching can be applied by teachers; c) teachers’ efforts for pedagogical enrichment of the school instructional context; d) pedagogical instrumentalization of digital technology; e) exploring and introducing new approaches to mathematics attainment evaluation. In an attempt to facilitate university students’ professional empowerment towards this direction, an educational game has been designed and evaluated as an alternative ecological approach to mathematical instruction that makes connections between mathematics and socio-economic problem solving. The idea of approaching mathematics as a socio-cultural product has been introduced and a very promising area for this notion is this concept of sustainability (Petocz and Reid 2003; Clarke 2012).

Sustainability has become a central notion in environmental policy discourse over the last two decades. Trying to regulate the relations between human societies and nature, sustainability is a complex and open concept that lends itself to many different interpretations (Liarakou and Flogaiti 2007).

However, there is some consensus that sustainability brings together three different axes: environment, economy and society. They constitute the pillars of sustainability: three interdependent and overlapping systems, the proper functioning of all three is a necessary condition for achieving sustainability. Environment refers to the effective protection of nature and prudent use of natural resources. Economy stems from the need to establish a prosperous and viable economic exchange which takes into consideration the limits of economic growth and is based on a redefinition of consumption levels. As far as society is concerned, human welfare and rights, promotion of democratic and participatory systems and processes are among the issues which play a key role in sustainability.

### **Description of Euro-Axio-Polis**

The game Euro-Axio-Polis was constructed according to the above mentioned constructivist theoretical background by 4th year university students in primary education and the first author from March to June 2012. The objective of the game is to teach the concept of ‘percentage’ and ‘interest rate’ to 6th grade pupils during their teaching practice. Additional aims of Euro-Axio-Polis are: a) challenging the prevailing function of mathematics as a means of reproduction of the dominant ideology and the market economy, b) raising university students’ and pupils’ awareness of sustainability and c) contributing to the students’ social empowerment and emancipation.

Euro-Axio-Polis rules have been designed to suit a classroom of approximately 20 pupils. Duration of the game is 40-50 minutes. Players are divided into five groups of four. Each team represents one of the 29 European Union countries that have financial transactions with the European Central Bank (ECB). All teams start from the STARTING POINT with one billion Euros in cash. Each country plays throwing the dice and, depending on the number it gets, places the pawn on the corresponding box. According to the options given in the particular box, the team decides on its actions. In the frames with the mark “YOU DECIDE”, the country gets a

card and decides on its next actions depending on the given options – dilemmas (e.g. What does your country choose? (A) to pay Doctors without Borders €170 million or (B) to receive for its treasury €170 million by cutting pension funds for the health of its citizens (See Figure 1). After the 50 minute duration, pupils vote which country is the winner according to their own criteria: the winning country may be the one that has raised the most money or has made the ‘best’ decisions, i.e. has the greatest number of (A)s or (B)s as in Table 1 below.

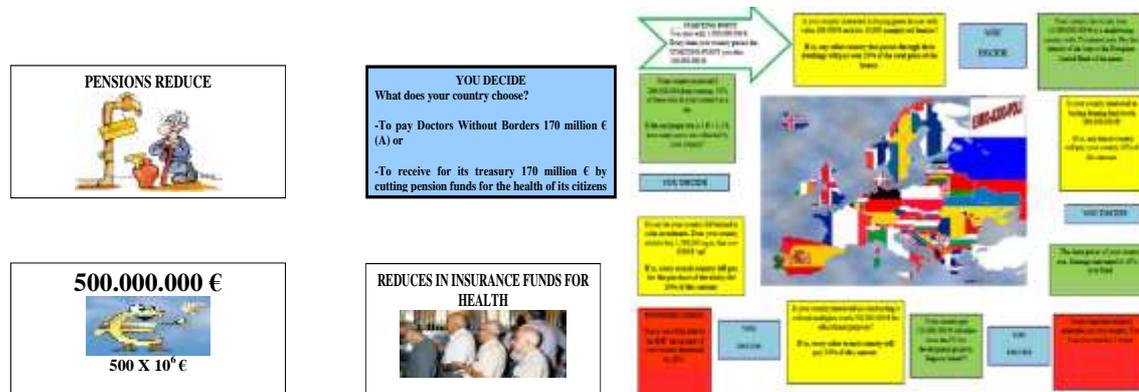


Figure 1 Example game cards and board

Sewage installation	(A)	Sale of Hazardous electronic waste	(B)
Financial aid to Child’s Smile	(A)	Sale of state land	(B)
Construction of Nursing homes	(A)	Pensions reduce	(B)
Construction of sports centers	(A)	Non-participation in the Olympics	(B)
Maintenance and enhancement of monuments and archeological sites	(A)	Sale of works of Art	(B)
Financial Support to Doctors Without Borders	(A)	Cuts in pension funds for public health	(B)
Total	X?		X?

Table 1: Grouping of decisions

## The research process

The game was played and evaluated by 40 senior students (3 males and 37 females) of the Department of Primary Education of the University of the Aegean and 19 pupils of sixth grade of the Primary School. The aim was to investigate the differences between the classic Monopoly game and Euro-Axio-polis. This assessment has been part of an ongoing process which includes a variety of techniques.

The qualitative method was chosen as the research approach. Data collection took place in the form of a written questionnaire, from which conceptual connections made by university students and pupils emerged. The questionnaire included two open-ended questions asking participants to write at least five words which, in their opinion, characterise Monopoly game in its classic form and Euro-Axio-polis game respectively. Having played the Euro-Axio-polis game, students and pupils answered spontaneously and without having been affected by predefined concepts of the researchers nor guided to specific answers. Data gathered from the above questions were based on the written responses of participants. They were organized in thematic areas, which appointed the classification of responses. Finally, qualitative data were interpreted into quantitative data.

## Results

University students' responses were grouped into classes according to their semantic content. Four categories were formed covering all the words that were recorded: a) financial terms b) game components c) values and d) mathematical concepts.

Regarding the keywords that characterize the classic Monopoly, the category with the highest frequency in students' responses is the one of financial terms. This class gathered a total of 51 reports while 12 different words were reported. The following terms gathered the most reports: buying and selling (15), money (10), investing (5), business (4), taxes (4), rent (4), bank (3) and shares (2). The second category, with a total of 12 references, is related to the game's components. The term with the most references in this category is the prison/jail (5) to which players can be sent. The second term is decision (2) the player should make about buying and selling.

The third category includes two values, competition (2) and individualism (2) and a reference of the term 'value'. Both values that were recorded are related to the capitalist economic model, in which the game is supported. The low percentage obtained by the fourth category of words 'mathematical concepts' is impressive because it was mentioned by only 1 student.

In the second question, in which University students were asked to write down words that characterise the Euro-Axio-Polis, the picture is different. The category that collected most reports (41) is that of values. Nine different values were reported with equity (21) in the first position; other recorded values were solidarity (4), charity (2), respect (2), active participation (2) and fellowship (2), while justice and altruism had only one report. In contrast with Monopoly, the reported values of Euro-Axio-Polis reflect - to a bigger extent - values inherent in sustainability. These values are also related to the economic realm, especially equity which refers to wealth distribution.

The category of economic conditions was in second place with 19 references. In contrast to the same category of the classic Monopoly game in which the term buying and selling dominated, most reports are compiled by the economic crisis notion (6) while the remaining terms refer to various economic terms such as money (5) and investment (3). The third category referring to the game's component got 17 references, including European countries (4) and sustainability (3). Finally, the category 'Mathematical concepts' had very few references in this question too: only two students reported on percentages and interest rate during the game which may mean that mathematics was an invisible culture for the majority of the students.

6<sup>th</sup> grade pupils' responses about Euro-Axio-polis were also grouped into classes according to their semantic content. Beside the four categories that emerged during the analysis of University students' answers, two new ones were added: socio-political issues and emotions.

The category with the highest frequency (28) in pupils' answers refers to the game's components. The following terms gathered most of the pupils' references: monopoly (9), countries (5), starting point (2), European Union (2) and decision (2). The difference from the University students' answers concerning this category is evident: while pupils refer mostly to descriptive elements of Euro-Axio-polis, University students reveal more qualitative ones (e.g. cooperation, dilemmas) and stress the elements that differentiate the play of the two games. Concerning the category of economic terms, the following ones gathered most of the students' notions: economics (9), euro (3), income (2) and tax (2). While current economic crisis terms were included in game cards, pupils reported a variety of other words related to the actual situation in Greece. Playing Euro-Axio-polis game brought to

their mind socio-political issues like politics (3), society (3), parliament (3), education, democracy, elections, power, SYRIZA (Radical Left Coalition Party), Merkel, Hitler.

The fourth category includes the following nine references related to mathematics: mathematics (5), percentages (2), operations (1) and numbers (1). This low frequency rate could be explained by the idea of mathematics becoming part of an 'invisible culture' in the pupil's eye. Ranked in fifth place was another category expressing pupils' emotions affected by Euro-Axio-polis game. The game seemed to create positive feelings in pupils since it was associated with joy (3), entertainment (2), enthusiasm and interest. Finally, in contrast to students, few pupils associated Euro-Axio-Polis game with values. The only value reported is charity, mentioned by six pupils.

## Conclusion

One of the objectives of the educational game Euro-Axio-Polis was to create an authentic, mathematics instructional environment in which concepts such as percentages and interest rates are embedded in some realistic and playful learning activities while, at the same time, mathematics education is meaningfully integrated in a realistic cultural context where the prevailing idea of mathematics as a politically neutral instrument at the service of a dominant capitalistic values reproduction ideology is under question. The latter is achieved when the players of this game are confronted with dilemmas and decision making situations in which socio-cultural issues, such as sustainability vs. economic investment and profit, as well as and value judgment discourse, were involved.

The results of this survey conducted with university students, as well as with 6th grade pupils, are encouraging. While, in the case of Monopoly, economic conditions and values that refer to the ascendant economic model dominate students' discourse, this is not the case with Euro-Axio-Polis. Here values such as solidarity, equity and social interdependence prevail, which are associated with sustainable development. The game also evokes the actual crisis in Greece, which resembles the current socio-political condition of other European countries too. University students highlighted terms related to economic crisis, while pupils referred mostly to socio-political aspects of the crisis. Keywords used by participants to describe the components of the game are very interesting. While in Monopoly terms describing the game (e.g. prison, command) are reported, in Euro-Axio-polis qualitative characteristics were brought up, such as cooperation between individuals and groups, resolving ethical dilemmas etc.

Furthermore, another significant outcome which rose through students' answers and may be worthwhile to be further researched, is the fact that only a few students appreciate that mathematics can be learned within a sociopolitical context. It seemed that mathematics in realistic contexts is an invisible culture (Chionidou-Moskofoglou, Vitsilaki and Vasiliadis 2006) for the most of university students and 6<sup>th</sup> grade pupils.

Future research attempt should focus on the investigation of how Euro-Axio-Polis embedded in school and lifelong learning curriculum and teaching approaches, should support university students and school pupils in developing meaningful, not isolated and functional mathematics in a socio-political context gaining happiness and independence in mathematics (Smith 2011).

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