Using Microworlds-Pro to support Effectively the educational Process

Sofia Kasola, *skasola@upatras.gr*
Researcher, Post-graduate student, University of Patras

Chris Panagiotakopoulos, *cpanag@upatras.gr*
Assistant Professor of Educational Technology, University of Patras, Dept. of Education

Panagiotis Pintelas, *pintelas@math.upatras.gr*
Professor of Computer Science, University of Patras, Dept. of Mathematics

Abstract

Microworlds are typical examples of digital open environments of learning, which give the pupils the possibility of exploration and active training. They are composed of a number of objects and relations as well as a number of operations that affect the objects, modifying their relations and creating new objects. They are open systems which the pupils can explore with minimal guidance, combining the commands of some language. Microworlds are usually interactive training environments

which allow the users to manage them at a very high level. A recently released software for the construction of microworlds is Microworlds Pro (MWP), which is based on the Logo language and offers several advantages. With the embedded capability of optical representation at the implementation of a program, the pupils can learn programming easily as well as to comprehend a program.

In this study we present the attitudes of candidate teachers with regard to the environment of MWP, and the effects of an application, developed with MWP, about understanding the phenomenon of alternation of day – night by young pupils. In order to explore the opinions of the selected sample, the participants were introduced to the MWP environment as well as to short applications constructed for 3 hours laboratory training. After this, candidate teachers answered a short questionnaire with open and closed questions. The findings of this research are that the environment is very easy to handle, enriches the educational process, promotes the active attendance and strengthens the interest and self-activity of the pupils. Furthermore, in order to explore the physical phenomenon of the alternation of day – night by young pupils, a MWP application was used. This application (SUN-EARTH-MOON: SEM), was constructed using the MWP environment and it contains simulations of planets and their movements. From the results of a pre-test, we realised that the pupils had confusions and misconceptions about this phenomenon even though they had taken school lessons. Using the SEM application, the pupils worked by themselves, with active attendance, they had the chance to explore the phenomenon and understand it working step by step. The post-test showed that they had approached the scientific model. From the final conclusions it is obvious that the MWP environment can improve and enhance the learning procedure, using appropriate applications.

Keywords

Microworlds, Logo, ICT, Exploratory Learning, Educational process, active attendance

1 Introduction

Recent theories concerning the way of teaching and learning include those that focus in the interaction entanglement of the pupils with the training materials, with the schoolmates and with their schoolteachers, so that the energetic learning is promoted (Hake, 1998; Novak, 1999). As it has emerged through the specific research, the use of such proceeding influences positively the comprehension of various significances (Hake, 1998). Often, the constructors of educational software try to adopt such theories. The present tendencies are directed in the manufacture of open environments of learning which either support or extend the theory of Papert (1980), where the knowledge is acquired through interaction with objects of real world or with digital objects that have all the attributes of the real ones.

The microworlds are characteristic formal examples of digital open environments of learning, which give to the pupils the possibility of exploration (diSessa et al., 1995). According to Ventrella (1993): “a microworld is a tool with which, one can learn about some aspect of the world and also about him or herself. An effective microworld encourages exploration, manipulation, and some degree of designing. Microworlds can model scenes from the real world in simple form - like animals, people, things - or they can even model collections of ideas, which can be manipulated and explored”. As Rieber (2005) mentions, the common points of the various theories regarding the microworlds in word bibliography, are that:

(a) They offer a way for more people, especially young, to understand and explore concepts and principles underlying complex systems.
(b) They focus primarily on qualitative understanding based on building and using concrete models, and
(c) There is a deliberate attempt to reduce the distinction between learning science and doing science.

According to diSessa (2000), a microworld that is created in an electronic environment of learning assembles and incorporates all the important significances, which the pupils can explore. In order to be effective a microworld should have simple operations so that the pupils focus in important training activities, which help them in the comprehension of fundamental values.

Microworlds are composed of a number of objects and relations as well as a number of operations that affect the objects, modifying their relations and creating new objects. They are open systems which the student can explore with minimal guidance, combining the commands of some language (Papert, 1980; Jonassen et al., 1998). Microworlds are perhaps the absolute example of active training environments, as the users have the possibility to manage them in a very high level (Jonassen et al., 1998).

As Papert mentions (1980), using Logo language, which has been the subject of extensive research, we can create such microworlds. In point of fact, the significance of microworlds began with the Logo programming language, which was developed in the MIT in the decade 1960 and became exceptionally popular with the charge of personal computers in the decade of 1980 (Papert, 1980; Rieber, 2006).

MicroWorlds, is one of a family of computer software applications generally known as multimedia. Designed as a true successor to the Logo environments of the 1980s, it still bears the stamp of Seymour Papert whose original idea for Logo was to give the power of the computer to children. Designed as a child-friendly piece of software, it is visually rich, has a good text editing facility, can manipulate text as well as graphics in a graphical way, and has the full Logo implementation as its scripting language. It is deliberately designed to fit into a constructivist classroom environment, or, using Papert’s construct of constructivism, “constructionist.” (Vincent, 2001).

A recently released software for the construction of microworlds is MicroWorlds Pro (MWP), which is based on Logo language and offers several advantages (LCSI, 2006, OWL, 2006). With the possibility of optical representation at the implementation of program, the pupils can learn programming easily as well as to comprehend a program (Logo Foundation, 2006).

Summing up, we could say that MWP is an open training and programming environment which:

- Offers capabilities for collaborative learning without particular difficulties for the user.
- Provides the user with facilities such as text processing, sound, video and animation.
- Includes the Logo programming language as well as other facilities such as buttons, links, etc.
- Provides the user with the capability of programming the turtle easily without requiring any particular knowledge of mathematics or algebra, as is the case with other programming software.
- Gives the user the capability to handle the turtle using elementary commands or design and develop sufficiently complex programming applications

On the other hand, it is known that the values, the attitudes, the convictions and the perceptions of teachers: (a) constitute the base in which they will be supported in order to seek their improvement and their professional development, and to maintain the communication with the scientific community (Matsagouras, 1998), and (b) (2) they influence their instructive - training practices (Reynolds, 1992).

In this paper, initially, are present the attitudes of a sample of fourth year pupils of the Pedagogic Department, at the University of Patras, Greece, for the MWP environment. These pupils will very shortly work as primary school teachers. Considering this, their opinions have particular importance. The data were collected after a 3 hour laboratory presentation of MWP, during which the possibilities of the program, and presentation of applications based on Micro words Pro were analyzed. Following is presented a study with the use of an application in the MWP environment, which was built in order pupils of Primary School to comprehend the phenomenon of alternation of day and night, which, as Vosniadou mentions (1994 and 1998) is one of the phenomena that pupils often have misapprehensions. The results from this study are also interesting.

In following section we present the attitudes of candidate teachers for the environment MWP, the experimental procedure for the phenomenon of alternation of day-night, the findings and the general conclusion about the use of MWP.

2 Attitudes of candidate teachers for the environment MWP

The sample of the research, which was carried out in November 2006, consists of 63 fourth year pupils of Department of Primary Education of University of Patras. The ages of the sample range from 19 to 21 years. 15 from them they were men (23.8%) and 48 women (76.2%).

After the presentation of the MWP environment, in laboratory, the pupils working in teams familiarized themselves with the geometry of the turtle and the additional multimedia capabilities. The presentation was focused in two applications with the use of MWP which we are reporting in the next paragraphs of this article. At the end of the 3 hours presentation, the pupils answered and recorded their opinions in a short questionnaire with open and closed questions.

In the question for the self-assessment of their knowledge in combination with their experience in handling of computer, in the scale Likert (1= non-existent, 2=few, 3=so-so, 4=enough], 5=perfect) the results showed mean 3.52 with standard deviation 0.76. The frequencies and the answers are in Table 1:

Non-existent	Few	So-so	Enough	Perfect
0 (0.0%)	5 (7.9%)	25 (39.7%)	28 (44.4%)	5 (7.9%)

Table 1: Self-assessment of the sample about the knowledge using computer

A small part of 11 pupils (17.5%) out of the total sample of 63 had some prior experience with MWP while the remaining 52 (82.5%) had no previous experience or knowledge of this environment.

In relative question about if the sample considers that the MWP environment promotes the exploratory learning the answers were 100% affirmative.

In the question for the degree of easiness or difficulty in handling the environment, with answers in the scale Likert (1= very difficult, 2= difficult, 3=So-so, 4= easy, 5= very easy), the results showed mean 4.08 with standard deviation 0.48. The frequencies and the answers are depicted in Table 2:

Very difficult	Difficult	So-so	Easy	Very easy
0 (0.0%)	0 (0.0%)	5 (7.9%)	48 (76.2%)	10 (15.9%)

Table 2: The opinions of the sample about the degree of facility or difficulty of MWP

The next question concerned whether the sample considered that MWP could be applicable in the daily educational process. The justification presented by those pupils who gave negative answers was that to use MWP in the daily practice requires total reformation of the Primary schools' analytic program. It should be pointed here, that in the Greek Primary Education system for the moment, there is no planned use of computer assisted learning.

We asked the sample to record positive points in the use of MWP for the schoolteacher. The aggregated of answers appear in Chart 1. Next, we asked the sample to record positive points in the use of MWP for the student. The aggregated answers appear in Chart 2.

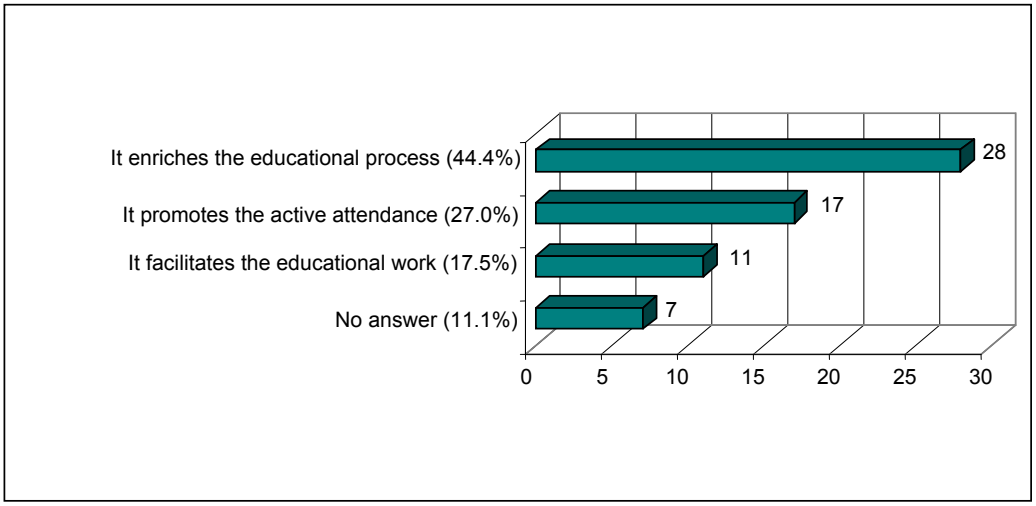


Chart 1: Positive points using MWP for the teacher, according to the sample

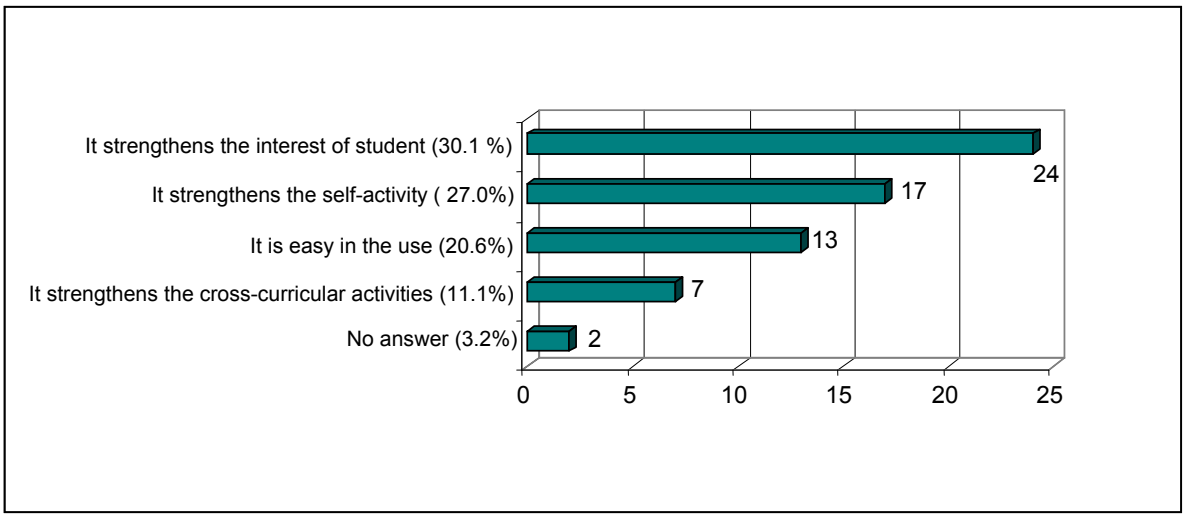


Chart 2: Positive points using MWP for the student, according to the sample

In our attempt to make the sample identify the negative points, from the teacher's as well as from the pupil's point of view, we had no such identification.

From the previous it results that the future teachers of the sample, have a positive attitude about the use of MWP software in the educational process. They expressed the opinion that it constitutes a tool which can strengthen the interest of the pupils, strengthen the self-activity and the active attendance, enrich and facilitate the educational process.

These views in combination with the views of the pupils which find MWP environment attractive can lead to conditions proper for learning by doing and learning by discovery.

3 The phenomenon of alternation of day - night

The main aim of this part of our research is to explore the effect of a simulation in the understanding of a physical phenomenon. Specifically, how 10/11 and 11/12 year old pupils understand the physical phenomenon of the rotation of the earth and the alternation between day and night. In order to perform this specific research, we constructed the application "SUN-EARTH-MOON" (SEM) using the software MWP v. 1.1, from Rainbow Computer Company, which is translated in the Greek language.

For this study we contacted a typical primary school in a suburban region near the city of Patras. In our research 46 pupils participated. None of the sample pupils had sight, hearing problems or learning difficulties. The average age was 10.51 years with a st.d. 0.31 of the 5th grade and 11.48 years with a st.d.=0.32 of the 6th grade. In the sample there were 26 boys (15 from 5th grade and 11 from 6th grade) and 20 girls (6 from 5th grade and 14 from 6th grade). The research took place during January 2005 in the PC lab of the school with "MWP 1.1" and the application SEM.

The research was performed by employing teams of eight pupils, where each student worked alone under the supervision of a tutor. Responsibility of the tutor was to take care to preserve the verbal framework in order to avoid any effects of what was said to the pupils. Pupils of the 6th grade had already been taught about the rotation of the planets around the sun, the structure of the solar system, the rotation of the earth around its own axis and the sun, and the existence of the moon as a satellite of the earth during their geography lessons.

3.1 The experimental procedure

The application SEM is designed and implemented in a way that approaches the study of the phenomenon with specific simulation on the screen, with the possibility of direct input by the pupils to address the objectives. The experimental procedure is divided into three parts. In the

first part, a questionnaire was given to the pupils with four questions marked as K1, K2, K3 and K4:

(K1) “Why do we have day?”

(K2) “Why do we have night?”

(K3) Why does the sun change its position in the sky?”

(K4) Why does the moon change its position in the sky?”

After completing the questionnaire, the pupils started working with the SEM application. In Figure 1a we can see the first phase of the application. When the pupils “clicked” on the earth, it started to rotate. The pupils then had to complete an appropriate questionnaire. The first question (D1) put to the pupils was: *“What do you notice?”* The correct answer was *“The earth rotates”*. After that, the tutor asked them to “click” onto the arrow at the bottom right corner of the monitor. Then, the pupils had Figure 1a in front of them.

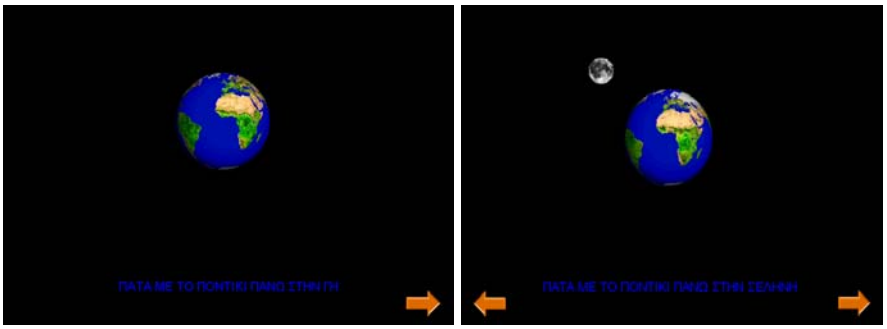


Figure 1a *Figure 1b*

***Figure 1a, 1b**: The first (la) and the second phase (1b) of the application SEM*

In the Figure 1b we can see the second phase of the application. When the pupils “clicked” onto the moon, it started to rotate around the earth. The pupils then were asked to answer the question (D2) which was: *“What do you see?”* The correct answer was *“The moon is rotating around the earth”.* They had to write their answer on the questionnaire. Next, the tutor asked to them to “click” onto the arrow at the bottom right corner of the monitor again.

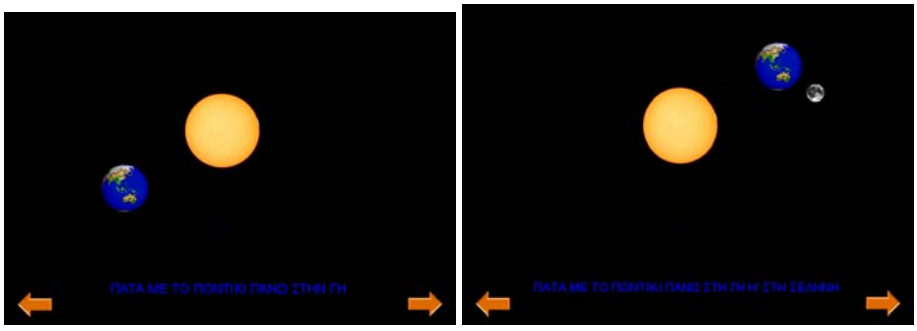


***Figure 2**: The third (left) and the fourth phase (right) of the application SEM*

In Figure 2 - left, we can see the third phase of the application. When the pupils “clicked” onto the earth, it started to rotate around the sun. The question put (D3) to the pupils this time was: *“What do you see?”* The correct answer was *“the earth is rotating around the sun”*. The pupils provided their answer on the questionnaire and then the tutor asked them to “click” on the arrow at the bottom right corner of the monitor again.

In Figure 2-right, we can see the fourth phase of the application. When the pupils "clicked" onto the earth or onto the moon, the earth started to rotate around the sun and the moon rotated around the earth. The question (D4) to the student was: *"What do you see?"*. The correct answer was *"The earth is rotating around the sun and at the same time the moon rotates around the earth"*. The pupils provided their answer on the questionnaire. The tutor asked them once again to "click" onto the arrow at bottom right corner of the monitor.

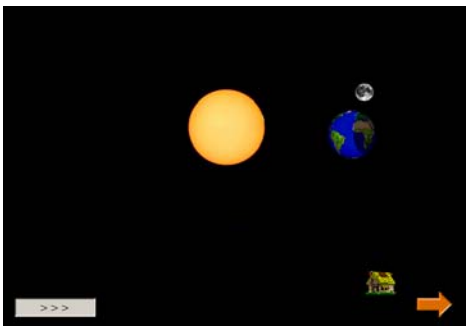


***Figure 3**: The fifth phase of the application SEM*

In Figure 3 we can see the fifth phase of the application. When the pupils "clicked" onto the grey button down to the left corner (>>>), the earth starts to rotate around the sun with the moon rotating around the earth at the same time. After a while, the tutor asked the pupils to "click" again on the grey button and then the earth and the moon stopped. The next question (D5_1) to the student was: *"Can you drag the house and drop it onto the earth at the side where is daytime?"*. The procedure with the grey button was repeated and when the earth and the moon stopped again, the question (D5_2) was put forward: *"Can you drag the house and drop it onto the earth on the side where it is night?"*.

The questions D5_1 and D5_2 were put to all the pupils in turn and under the guidance of the tutor. The question Q5 was considered correct only if the pupils had answered correctly both question D5_1 and D5_2. At this point we asked the pupils to answer the same four questions, just as before the procedure with the SEM application.

3.2 Findings and discussion

The statistical analysis has been performed using level of significance 0.05. The obtained results came from a sample that was, in general, from families with parents of a relatively low social and financial background. From the statistical analysis there has not been any significant difference observed in the responses of pupils originating from different social and financial backgrounds, or due to the professions of their parents. The same is also true concerning the gender of pupils.

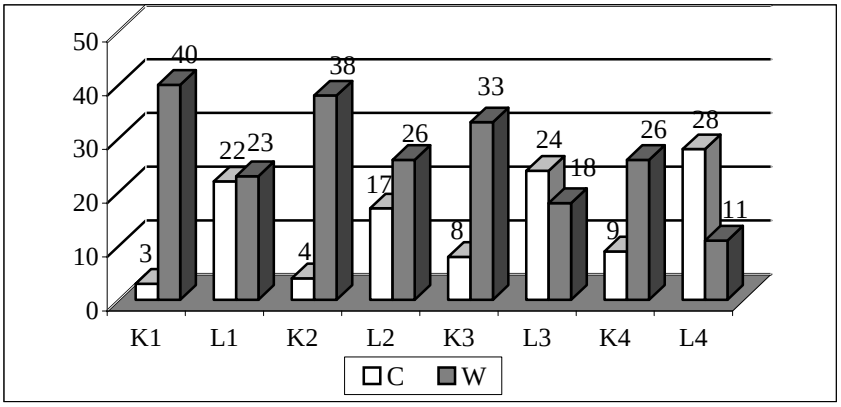
Of the 46 pupils in the sample, 4 (8.7%) claimed that they use the computer for their homework (educational software, encyclopaedias, Internet). Of these 4, 2 originated from the 5th grade and 2 from the 6th grade. Thus we may consider that, the sample had no experience using computers and educational software.

As previously mentioned, the questions K1, K2, K3, K4 were asked of the pupils just before the use of SEM Microworld application. The exact same questions were asked of the pupils just after the use of the SEM and they are noted in table 3 as L1 to L4, respectively. The overall results are shown in table 3 per question and per grade, before and after the use of the software.

		Questions K1 to K4 and L1 to L4							
		K1	L1	K2	L2	K3	L3	K4	L4
5th grade	Correct	0 0.0%	11 52.4%	0 0.0%	7 33.3%	1 4.8%	9 42.9%	1 4.8%	12 57.1%
	Wrong	20 95.2%	10 47.6%	19 90.5%	14 66.7%	20 95.2%	10 47.6%	15 71.4%	6 28.6%
	No answer	1 4.8%	0 0.0%	2 9.5%	0 0.0%	0 0.0%	2 9.5%	5 23.8%	3 14.3%
6th grade	Correct	3 12.0%	11 44.0%	4 16.0%	10 40.0%	7 28.0%	15 60.0%	8 32.0%	16 64.0%
	Wrong	20 80.0%	13 52.0%	19 76.0%	12 48.0%	13 52.0%	8 32.0%	11 44.0%	5 20.0%
	No answer	2 8.0%	1 4.0%	2 8.0%	3 12.0%	5 20.0%	2 8.0%	6 24.0%	4 16.0%

Table 3: *The frequencies and the percentages of the correct (C) and wrong (W) answers of the pupils of the 5th and 6th grade in each of the four questions before (K1 to K4) and after (L1 to L4) the use of microworld.*

It is evident from this table and from Graph 3, which gives the frequencies of the correct and wrong answers, that the wrong answers have been significantly reduced after the use of SEMI application. From the data analysis it is determined that there are significant statistical differences in the responses of the pupils, overall and per grade, before and after the use of the software. Using the t-criterion, the results for the 5th grade are: $t(41)=-6.089$ and $p<0.01$, while for the 6th grade they are: $t(22)=-3.53$ and $p<0.05$. For the total number of pupils the corresponding results are: $t(18)=-5.43$ and $p<0.01$.



Graph 3: *Graphical representation of the frequencies of the correct (C) and wrong (W) answers of the pupils of both grades in each of the four questions before (K1 to K4) and after (L1 to L4) the use of microworld.*

The statistical results of the answers, per grade, before and after the use of the microworld are very interesting. Using the t-criterion, the result of the answers to the questions L1 to L4 per grade before the use of the microworld verifies the presence of significant statistical differences

(t (40) =-2.66; p<0.01). From the findings it was determined that the pupils of the 6th grade gave correct answers in a greater percentage than those of the pupils of the 5th grade and this can be considered as normal. The factors that affect this result could be the age/grade and existing knowledge and it must be mentioned at this point that the pupils of the 6th grade had already been taught by their teacher about the concepts in SEM. The remarkable point is that the results in the answers L1 to L4 per grade, after the use of the microworld, using the t-criterion did not show the presence of significant statistical differences t(43)=-0.724; p>0.05). What has happened between the pupils giving answers to the questions K1 to K4 and to L1 to L4, was the use of SEM microworld, consequently this differentiation is derived from its effect.

4 GENERAL CONCLUSIONS

The candidate schoolteachers of the sample have, in general, positive opinions for the MicroWorlds Pro environment and they believe that using it, can strengthen considerably the educational process. These opinions, combined with the views of the pupils which find MWP environment attractive can provide the justification for the assertion that MWP effectively improves the educational process.

From the second part of our research, data analysis has shown that a significant percentage of the pupils disprove their initial misconceptions and they recognize the role that the rotation of the earth around its axis plays in the alternation between day and night. They approach the scientific model without the need for additional instruction from the tutor. It appears that the pupils using the simulations had the chance to explore the phenomenon and step by step to understand it. An important number of pupils showed that they can exceed the misconceptions and they can approach the scientific model for the particular phenomenon.

Form the final conclusions it is obvious that the MWP environment, using appropriate applications like SEM, can improve and enhance the learning procedure.

References

diSessa, A. (2000). Changing minds: Computers, learning, and literacy. Cambridge, MA: The MIT Press.

diSessa, A., Hoyles, C., Noss, R., & Edwards, L. D. (Eds.) (1995). Computers and exploratory learning. New York: Springer.

Hake, R. (1998). Interactive engagement vs. traditional methods, American Journal of Physics, 66, 64.

Jonassen, D. H., Carr, C., Yueh, H.-P. (1998). Computers as Mindtools for Engaging Learners in Critical Thinking TechTrends, v43 n2 p24-32.

LCSI (2006). MWP. Available on line: http://www.microworlds.com/ [retrieved on 12/20/2006].

Logo Foundation (2006). Available online: http://el.media.mit.edu/logo-foundation/index.html [retrieved on 12/20/2006]

Matsagouras, H. (1998). “Theory of teaching: The personal theory as a frame of thinking and critical analyzes”. Gutenberg Publications, Athens, Greece.

Novak, G., Patterson, E., Garvin, A., Christian, W. (1999). Just-in-Time-Teaching, Prentice Hall, NJ.

Open World Learning (2006). MicroWorlds in Action. Available online: http://mia.openworldlearning.org [retrieved on 12/20/2006].

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. New York: BasicBooks.

Papert, S. (1991). Situating Constructivism, in Constructivism, Harel, I., Papert, S. (eds), Ablex Publ., NJ.

Reynolds, A. (1992). What is competent beginning teaching? A review of the literature. Review of Educational Research. Spring, 62, 1, pp. 1-35.

Rieber, L. P. (2005). Multimedia learning in games, simulations, and microworlds. In R. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp. 549-567). New York: Cambridge University Press.

Rieber, L. P. (2006). Supporting Discovery-Based Learning within Simulations. Available online: http://www.iwm-kmrc.de/workshops/visualization/rieber.pdf [retrieved on 12/20/2006].

Ventrella J. (1993). Attractions and Repulsions - A Gravity-based Animated Microworld for Exploration of Dynamical Systems. Available on line: http://www.ventrella.com/Ideas/attractions.html (retrieved on May 26, 2007).

Vincent, J. (2001). Microworlds and the Integrated Brain. 7th World Conference on Computers in Education, Copenhagen, July 29–August 3, 2001.

Vosniadou, S. (1994), The conceptual change in the children's age: examples from the field of astronomy. In: Representations of natural world. V. Koulaidis (ed.), Gutenberg, Athens (in Greek).

Vosniadou, S. (1998), Cognitive Psychology: Psychological studies and essays, Gutenberg, Athens (in Greek).