Science Education and E- Learning and Teaching for Secondary Education

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Abstract. *The main purpose of this paper is the practical implementation of on line learning in the area of secondary education, in particular for the teaching of Science. Moodle 1.9.5 is used for the creation of the virtual classroom. Strategies against students' erroneous perceptions of electrical circuit's matters are put into practice. Synchronous and a-synchronous communication is tried especially among the students as well as between students and the instructor aiming at cooperative learning. The analysis of the worksheets and the meta-cognitive questionnaires results shows a small improvement in the performance of students and a relative conceptual change. The positive attitude that is observed towards the model of blended learning and the LMS Moodle, do not appear to have high cross-correlation with the use and intention of use. This fact is also verified by the system's log files of students' participation in the attendance of internet courses and by the final acceptance questionnaire.*

Keywords. Science Education, Students' perceptions, Learning management system, Moodle, e-learning, TAM.

1. Introduction

Contemporary studies in Natural Sciences didactics have focused largely on the examination of students' ideas/perceptions on concepts and phenomena within the field of Natural Sciences, generating an important international bibliography on the subject. This paper examines students' perceptions on the subjects relating to electric circuits. We shall identify the models which continue to obstruct the comprehension of concepts and functions on the learning subject of electric circuits, in the age group of students in the second year of secondary education (lyceum). The aim of this paper is to get students acquainted with the model of mixed learning as well as the use of Moodle environment. We shall study the levels of improvement in students' performance, their view towards the introduction of a computer system in Natural Sciences education and also the levels of participation in interactive classes. We shall explore the relation between the perceived usability and the actual ease of use of such system, as well as the views towards a virtual learning environment, the model of mixed learning and the use and availability of interactive classes in other subjects.

2. Theoretical background

Information and Communication Technologies (ICT) and Natural Sciences (NS)

Information and Communication Technologies (ICT) are considered to be largely applicable on Natural Sciences (NS) because they enable representation of phenomena, they foster experimental study and they enable the creation of models and problem solving applications. There is a large number of ICT developed for NS didactics, such as spreadsheets, presentation software, microcomputer-based laboratories (MBL), multimedia, simulation models, research and interactive learning environments. All of the above aim to actively engage the student into the research process and offer the teachers the opportunity to work in such conditions which would not be viable or possible in a traditional learning environment.

Despite the general findings in what we expect from ICT in education [9], [3], as deriving from everyday practice and studies, we can observe a relative improvement on learning performance, on one hand, but still the conceptual transformation is not largely benefited, on the other hand. The introduction of

ICT in Didactics and Education as applied now is not yet as effective as we have initially expected.

Students' perceptions

Recorded students' perceptions on electric circuits are as follows: When subjects relating to electricity in simple circuits are studied, there are five models in use: a) unipolar, b) "clashing currents", c) attenuation, d) partitive (cases c and d are consuming models) and e) scientific [10]
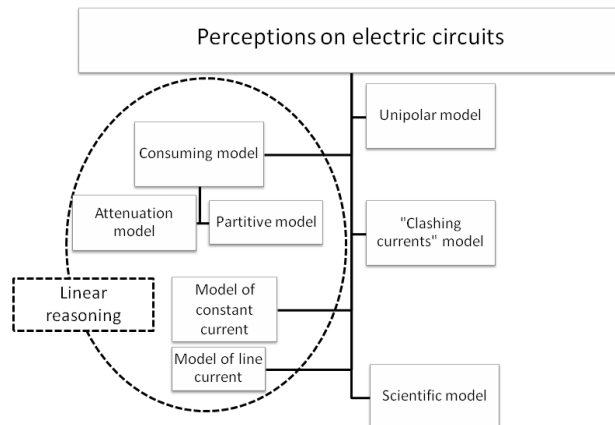

Figure 1. Mental models on electric circuits

Behind these models lies a common perception: electricity starts from the battery and following a linear flow, meets the cables, the resistors, the lamps and other parts of the circuit as it passes through, thus resulting in another mental model, especially when more complex circuits are involved [8].

According to studies, as age and didactics proceed gradually, there is a transfer from unipolar to scientific model. Shipstone[10] found that 50% of 12-year-old students in elementary school adopt consuming electricity models, the same percentage growing to 60% for 14-year-old students and falling below 40% for 17-year-olds. The scientific model involved less than 10% of 12-year-old students, less 40% of students of 15 years and just 60% of 17-year-olds. 50% of 15-year-olds have adopted a consuming electricity model. Nevertheless, even after graduating from secondary education, students in their majority support the consuming model or electricity maintenance [8].
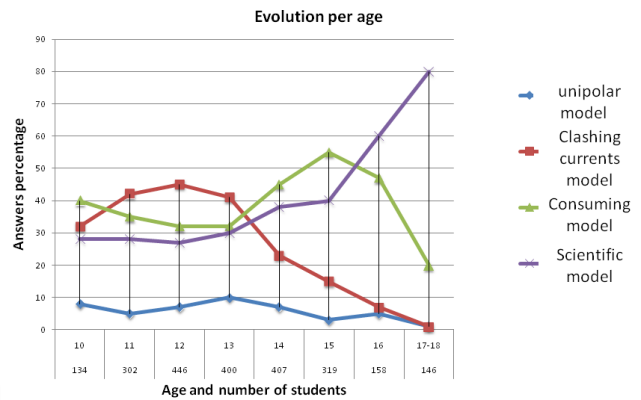

Figure 2. The evolution in model adoption for electric circuits per students' age [8]

The difficulties students are faced up with cannot be dealt with by means of traditional didactics, which is based on quantitive approach of electric phenomena and thus students learn mainly to solve mathematical equations. In the framework of general education, students should develop model building skills and a comprehension of their nature, using PCs and the appropriate model building software. ICT use for problem solving requires the application of Computer Science principles according to the following scheme: Problem ↔ theory ↔ model ↔ simulation method ↔ effectuation (using programming languages or software) ↔ evaluation (comparison to actual data) [7]. The objective in the above scheme is transforming the phenomena from the abstract level to a scientific model, which shall in continuance be tested with regard to its evaluation and validity [7].

Certain difficulties in applying the above are: time restrictions in school educational programs, schools' infrastructure in our country, practical difficulties in computer and internet access concerning natural phenomena simulation when children are in school and the established teacher-centered model. Space and time restrictions and also the issues relating to the difficulty of applying an alternative pedagogical framework within the natural school space, may be overcome by means of distance learning, through a particular learning management system. This paper examines among other questions the extent to which such an interactive platform can be used to eliminate such restrictions.

e-learning

The development of distance learning systems along with technological advancements enable the creation of a new dynamic technology in e-learning. This new technology aims to exploit ICT and the internet for improving the quality of education offered. We are in the 5th generation of e-learning and according to Taylor (2001) [11] «…the only constant in our era is change». In the current era of technology, information transfer cannot be restrained by obstacles such as distance or time. Offering education from distance in the era of e-learning is not either a simple or easy task. According to Karakirios, Kekkeris, Paliokas, Reppa-Athanassoula, & Psycharis (2009) [5], in order to establish an educational activity, irrespective of the media used and the distance (in time as well as in geographic terms), there are three prerequisites: the people (educators, pupils, administrators) who take part in any way, the procedures or techniques which are followed and the learning material, i.e. the educational media in any form. The combination of the above factors can lead up to offering quality distance learning.

LMS - Moodle

LMS (Learning Management System) is a software platform for managing a coherent educational electronic system. In particular, through LMS the management of electronic classes and the educational material in general is made possible, such as developing classes through the platform authoring tools, introducing predesigned classes, and modifying, enriching or deleting their content. Users registration can thus be automated and access to classes can be controlled. Users' actions can be monitored from the moment they enter the platform to the moment the exit the system. Monitor data are available to platform administrators and the teachers of the classes.

Moodle (Modular Object Oriented Dynamic Learning Environment) is an electronic learning environment (Learning Management System, LMS) which came to attention in the 1990s by Dr. Martin Dugiamas, specializing in Computer Assisted Education. The development of Moodle was based on a learning philosophy known as «social constructive learning» Social constractionist pedagogy includes the concepts of Constructivism, Constructionism, Social Constructionism.

The present paper was based on the use of Moodle environment. The platform was installed in the web server www.hostgator.com, and the page under the domain name: www.e-sxoleio.net, which was created for the needs of the present paper, under the following characteristics: Apache 2 (version 2,2,11), Mysql5 (version 5.1.35), Php5 (version 5.3.0), Moodle (version 1.9.5), PhpAdmin (version 3.1.2).

TAM

The Technology Acceptance Model (TAM) is a commonly used model which provides for and explains the use of computer systems. It is a model which explains the adoption behavior of computer systems by the users and calculates the level of acceptance. TAM by Fred D. Davis is a computer system theory which examines how the users receive and thus how they make use of a certain technology. According to this model, the adoption and use of computer technology lies upon two major factors, the Perceived Ease at Use and the Perceived Usability. Davis' model (1993) [2] is completed by the following concepts:
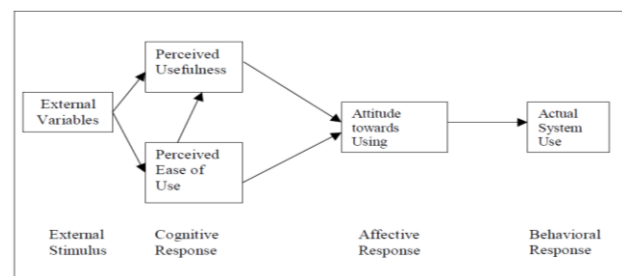
Figure 3. The three phases in TAM: cognitive, affective, behavioral

This paper makes use of TAM declarations for evaluating the Moodle platform in the framework of NS classes.

3. Methodology of the study

Aims of the study

The aim of the study can be divided into two major sub-domains, as hereby described below:

A. *The domain of Natural Sciences Didactics:*

A1. Applying strategies for correcting the wrong perceptions of students in the field of electric circuits, by introducing the appropriate

educational activities which shall lead to conceptual transformation.

A2. Evaluating the efficiency of educational tools with regard to learning objectives.

B. *The domain of ICT in education:*

B1. Creating, developing and applying an interactive *learning* environment at school level by use of the distance learning platform Moodle.

B2. Exploring the response model of Learning Management *System*, its use and intention of use.

Sample – Procedure of the Study

The sample of the students in the study were 25 students, 12 boys and 13 girls in the second year of Sidirokastro General Lyceum in the school year 2009-2010. The learning level of the participants is characterized good to excellent, based on the students' grades. Each group consisted of students who had grades of between 14 and 19,9 from all routes available.

The criterion for the school selection was the fact that it is a typical, district school. As far as the social status of the students is concerned, the majority of them come from agricultural or labour backgrounds (children of workmen or employers in private or public organizations), which corresponds to the vast majority of economically active population in Greece.

One motivation for the students' participation was the awarding for participation in terms of grade, to a percentage of 40% in the final grade of the participants (60% from class performance and 40% from participation and performance in the computer environment).

In the first phase, the implementation and application of a scaled weekly plan of classes and activities was studied, based on the following bibliographical references: distance learning principles, classes organization models, material and distance learning development, the guidelines of the Comprehensive Programme of Studies, the selected pedagogical framework, the theory on students; perceptions of electric circuits.

In this phase,the installation and organization of Moodle platform was planned, the requirements with regard to hardware and software material were also determined and finally, the server for the webpage hosting the educational and learning environment, including a computer system for direct and indirect distance learning, was selected.

In the second phase, the efficiency of educators' interference was applied and evaluated, based on results from spreadsheets. In addition, the use and response to the educational and learning environment was evaluated by means of the system's log files and the respective response questionnaire.

The strategy base on case study was used. The study conducted is in the form of a review. This review consists of data collected by different sources (questionnaires, Moodle participation registration, Quiz tools in spreadsheets) in the given time period. Data collected either describe the existing conditions or determine the relations between the facts [1].

The conduction of the study was based on the quantitative approach. The spreadsheets and questionnaire on meta-learning experience consist of closed questions, in true-false and yes-no format. The final response questionnaire consists of closed questions, under the Likert evaluation format and includes five possible answers to each question. The system's log files include numerical data, picturing the participation (for example, entries to the system per student).

The process of the data is based on descriptional, statistical methodology (data presentation in tables and figures). For performance examination in spreadsheets, on the first level, there is the normality test Kolmogorov-Smirnov and the t-test evaluation on dependent samples (performance before and after teaching). In addition, the criterion Wilcoxon signed rank was used to make the comparison (between performance before and after), in cases where there is a variation in the normality test.

The final questionnaire is examined in terms of validity and reliability. In order to establish the conceptual construct validity of the questionnaire, the factual structure is examined, using the principal components analysis method.

The evaluation of reliability is based on the internal effect with criteria method, the Cronbach "α" method, the item-item correlation testing and the corrected item-total correlations, in order to evaluate each question under this scale. Data processing is performed using the SPSS program, version 17.

4. Results

Transformation of perceptions (A)

As far as the exploration of alternative ideas on electric circuits are concerned, it has been found that, according to the questionnaire on students' perceptions, the current bibliography is confirmed and it is further shown that in the age group examined the wrong ideas are eliminated to concrete obstructions in the linear reasoning. The repetition of ideas' exploration 20 days after the conclusion of the classes and the completion of the spreadsheets has shown that the percentages of adopting wrong perceptions are reduced in comparison to the former ones. This fact further confirms the studies claiming that the reduction in the levels of model adoption is related to the strategies for correcting such perceptions. Nevertheless, there are certain perceptions which tend to persist, even after such interference on the part of the educators.
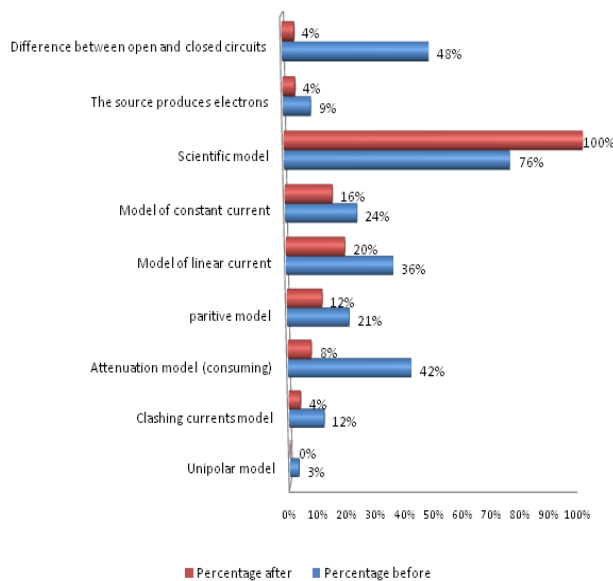

Figure 4. Students' perceptions

The improvement in students' performance, as shown in the completed spreadsheets, is quite significant statistically, in two of the three spreadsheets.

		N	Mean Rank	Sum of Ranks
fe1_ana - fe1_pro	Negative Ranks	2[a]	5,50	11,00
	Positive Ranks	6[b]	4,17	25,00
	Ties	17[c]		
	Total	25		
fe2_ana - fe2_pro	Negative Ranks	3[d]	5,67	17,00
	Positive Ranks	10[e]	7,40	74,00
	Ties	12[f]		
	Total	25		
fe3_ana - fe3_pro	Negative Ranks	2[g]	11,00	22,00
	Positive Ranks	12[h]	6,92	83,00
	Ties	11[i]		
	Total	25		

Table 1. Spreadsheets results

The constructive approach through Moodle platform ,within the framework of the present case study, is considered relatively satisfactory. The views of the students towards this mode of education were rather positive. Similar papers on NS teaching, such as Crippen & Earl's (2007) [6], have found that the results from the educators' interference do not generally depict a statistically significant variation in terms of average grades in the subject of Physics on the internet. However, there has been an improvement on homework assigned. Furthermore, the views of the students towards studying at home based on the internet appear to be of positive nature [6].
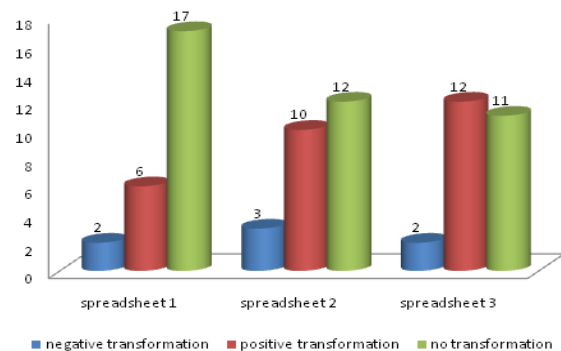

Figure 5. Performance improvement in spreadsheets

The collaboration among the students working in groups has had an effect on 1/3 of the students' sample, who changed their decisions towards the correct answer, as shown in the study of the answers to the questionnaires of meta-learning experience. This can be due to various factors, such as: the nature of the activities, the limited familiarization with this particular mode of learning, the lack of intention to collaborate, the common way of thinking among students who are well acquainted with one another (which also consists a restriction in this particular study). Besides, the mode of teaching NS and other subjects in schools is not oriented towards team-working learning activities and as a result the students' levels of collaboration are low, since never before had they participated in such an experience.

Development and Application, and response to the LMS (B)

As far as the development, application and function of an interactive environment is concerned, it has been found that the educator who shall attempt such a task shall be faced with difficulties of technical nature and functionality,

from the start. As a consequence, issues such as hosting, platform installation to a large or smaller extent, can be considered as an "adventurous" and demanding attempt. The knowledge required has not yet been available to educators today by means of any educational programme.

The participation rates have shown that in the initial, pilot application of the system there has been an increased rate of participation, probably due to the curiosity involving something new taking place in school, but as far as participation during the experimental application is concerned the rates were decreasing, as resulting from the examination of the relevant log files.
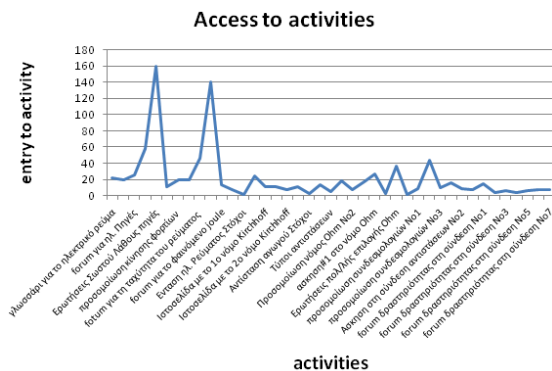
Figure 6. Participation chart in terms of time per activity

The students' outside school preoccupations (such as educational activities, sport, etc.) result in diminishing free time, which acts as a preventive factor to consistent participation. The students claimed they prefer to surf the internet without particular purpose, including social networking webpages such as www.facebook.com, rather than get involved in or spent extra time on the subject of Physics on the internet. The grade (a percentage of 40% of total grade) as a means of motivation and awarding for participation did not appear to play a significant part. This is clearly due to the recently noted indifference of the students towards subjects of general education and their concentration on route subjects. The examination system for entering Higher Education has, therefore, formed particular tendencies and results in similar views and behaviours on the part of the students, same as far as ICT are concerned.

The creation of the questionnaire was based on a study of relevant to the research questionnaires, bibliography and online websites. Additionaly, Moodle environment is included in COLLES questionnaire, the examination of which has been helpful in forming some of the questions in this particular questionnaire.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,571
Bartlett's Test of Sphericity	Approx. Chi-Square	262,168
	df	136
	Sig.	,000

Table 2. Sample Efficiency

Reliability Statistics

| Cronbach's Alpha	N of Items
,552	17

Table 4. Scale Reliability

Factual correlations in the questionnaire, as answered by the students, show that: The Perceived Usability (PU) of the System relates loosely to the positive view towards the system (EA), whereas it does not relate at all to the behaviour towards the use or the actual use (AS). In addition, the perceived ease at use (PE) does not relate to the positive view towards the system (EA) and its relation to the intention of use (AS) is limited. Finally, there has been found no relation between the positive view towards the system (EA) and the intention of use (AS). The conclusions as set above have been taken into consideration and have been confirmed in the system's log files (course view).

Factor Loandings for Measures o Constructs

	PU	PE	EA	CTA	AS
Perceived Usefulness PU (Cognitive response) Factor 1	,800 ,933 ,902 ,735				
Perceived ease PE (Cognitive response) factor 4		,953 ,818 ,860			
Environment Attitudes EA (Affective response) factor 5			,530 ,878 ,688		
Collaboration and teaching attitudes CTA (Affective response) factor 3				,788 ,928 ,919	
Actual system use AS (Behavioral response) factor 2					,805 ,834 ,355 ,859

Table 4. Varimax rotation

Component Correlation Matrix

Component	1 (PU)	2 (AS)	3 (CTA)	4 (PE)	5 (EA)
1 (PU)	1,000				
2 (AS)	-,062	1,000			
3 (CTA)	**-,269**	-,082	1,000		
4 (PE)	**,217**	**-,240**	-,189	1,000	
5 (EA)	**,328**	-,024	-,125	,005	1,000

Table 5. Matrix of factual correlations p<0,01
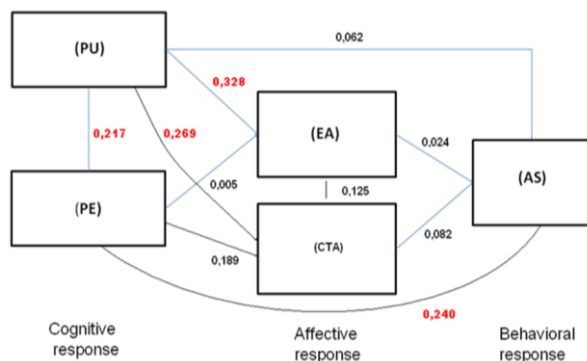
Figure 7: Factual correlation of response questionnaire

5. Conclusions

The students, being in their majority acquainted with PC use and the internet, can generally learn and use easily an interactive environment, such as Moodle. They can also perceive its usability in terms of the opportunities it can offer. However, the relation between the positive views towards the System, its use and the intention of use with the perception of its usability and ease at use, is affected on a large scale, by other factors. The need for free time, the general views towards school reality and learning in school, the way of life (role-models, values, behaviours) depicted in mass media, the mentality and practices of most educators (but for limited exceptions), the lack of team-working experience, are all such conditions which require examination in order to establish how much they relate to the success or failure of e-learning.

It should be possible for the use of interactive educational platforms to achieve the aims set, if the students are activated towards the educational procedure and take full advantage of the possibilities that technology offers to direct and indirect effects within the society. Naturally, this is also related to the Comprehensive Programme of Studies, which should be modified and

oriented towards ICT [4]. The above is further confirmed by the fall in participation in the duration of time.

The development and exploitation of an effective Educational Software is not a new issue. However, has it ever been student-centered and constructive enough? In most cases Teaching - Learning stereotypes are reproduced, wrapped up in a New Technology "packaging".

We shall not always consider anything new as something innovative and something to be adopted without control and consideration of other factors.

The conclusions of data processing of the programme PISA 2003 underline the negative and limited relation between new technologies use (PC, internet) and the learning and students' performance [9]. The same fact is confirmed in the study of performance spreadsheets.

The choice of an appropriate pedagogic framework, the development, structuring and planning of learning through LMS require that educators who undertake such a project are familiar with ICT as well as well trained in pedagogic issues as well as in ICT, in order to support the achievement of teaching aims. Apart from careful planning and determination of aims, it is vital that certain factors are considered: educational staff, material and procedures [5].

Finally, there is the need to specify the framework for the «Rules of Operation and Exploitation of ICT in Education». The educator who desires to take part should not only be eager and attentive, but he/she should be quite certain for «what is to be used, how to use it, where to publish it, who have the right or the obligation to access it, who controls it.

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