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IMPLEMENTING A FLIPPED CLASSROOM: A CASE STUDY OF BIOLOGY TEACHING IN A GREEK HIGH SCHOOL

Angeliki GARIOU-PAPALEXIOU
Greek Ministry of Education
Secondary Education, School Director
Patras, Greece

Spyros PAPADAKIS
Hellenic Open University
Patras, Greece

Evangelia (Gelly) MANOUSOU
Tutor Counselor
Hellenic Open University
Athens, Greece

Irene GEORGIADU
Hellenic Open University
Patras, Greece

ABSTRACT

The purpose of this study was to investigate the application of the model of the "flipped classroom" as a complementary method to school distance education in junior high school Biology. The "flipped classroom" model attempts a different way of organizing the educational process according to which the traditional methods of learning at school and studying at home are interchanged, the learners' active involvement is supported, their autonomy is reinforced, ICT is utilized and learning occurs partially by distance (blended learning). We performed an action research implementing flipped classroom in Biology teaching in a class of 17 students attending the1st year of junior high school. The educational platform used was the Learning Activity Management System (LAMS). The findings were evaluated qualitative rather than quantitative, and can provide evidence about the prevailing situation. During the action research, it became evident that time management in the classroom was improved. Furthermore, it was observed that students' involvement in the educational process was also improved. Students had already familiarized themselves with the cognitive aspect of the lesson before entering the class and they considered the learning process as an individual affair which does not only depend on the teacher. The implementation of digital activities accomplished by distance led to taking action and initiative and finally to active learning. School distance education combined with the radical development of ICT can be complementary with the use of various methods, like the "flipped learning", and give a new perspective and potential to the limited choices of conventional education in the Greek educational system which is worth further investigation.

Keywords: **School complementary distance education, blended learning, flipped classroom, junior high school Biology, photosynthesis, LAMS (Learning Activities Management System).**

INTRODUCTION

Learning is not a product which is transferred through the instructive action from one source to another one or by from one region to another one or from an empirical – philosophical dimension to another one (Lionarakis, 2003). It is a product that is discovered from the person himself interested through concrete practices and methods. Although the modern theories of learning recommend the biggest possible entanglement and activation of the student, research shows that the educational process in secondary education continues to take place in the traditional way, where the student is mainly a passive receptor. This is due mainly to the fact that the time for the delivery of the curriculum is not sufficient.

Limited time is a common situation that Greek classroom teachers face, and it can have a significant effect on the learning process. While dealing with this issue, a new, modern learning method, which is a combination of distant and traditional educational strategies came up. This approach is called "the flipped classroom" and its applications appear to be beneficial for time management and the students' involvement in the educational process (Estes et al.; 2014; Kurtz et al., 2014; Bergmann et al., 2011).

The purpose of this paper is to define how the "flipped classroom" could work as a complementary education method in Biology teaching in High school. The following research questions are being studied:

- **How could the "flipped classroom" be effectively used as a complementary distant education method?**
- **In what way can the "flipped classroom" help improve the learning process?**
- **What are the difficulties we faced when we applied the "flipped classroom" method in a Biology class?**

The discoveries give new prospects and possibilities of the contribution of school distance education in the Greek educational system. The "flipped classroom" provides an opportunity to capture the attention of Millennial students and thus improve their learning experience. In the next sections, theoretical introduction, research part, results, discussion, conclusions and recommendations are presented.

THEORETICAL PART

School Distance Education

Distance education can be utilized for the needs of school education (Anderson & Dron, 2011). The term "school distance education" defines the education of elementary and secondary level, which is provided to students of school age as well as to adults (Vasala, 2005). The application of school distance education is of high importance in providing equal opportunities and fighting social exclusion (Themelis, 2001; Manousou, 2008; Cleveland-Innes & Garrison, 2010). Nowadays distance education methods achieve high degree of interaction between the teacher and the learner regardless of distance (Dede, 1996). An instance of distance education consists of the virtual teaching and learning environments which give the opportunity to learners and teachers of different geographical areas to add up to a class, communicate at any time, collaborate, participate in discussions and interchange aspects, experiences or concerns (Mauger, 2002).

In Greece, innovative teachers make good use of complementary school distance education in various fields, such as extracurricular projects (Cultural, environmental, e-Twinning) (Manousou, 2008; Papadakis et al., 2014). We have to take into consideration that distance learning is not part of the institutional framework in the Greek educational system. The "flipped classroom model" constitutes an approach where the learners' active involvement is supported, their autonomy is reinforced, ICT is utilized, learning occurs partially by distance (blended learning) and supplements school education.

The Pedagogical Model of the "Flipped Classroom" Approach

The term "Flipped Learning" or "Flipped Classroom" is used to describe a relatively new instructional design approach in schools, reversing the hitherto followed structure. Founder of the "Flipped Classroom model is considered Baker who in 2000 presented a model entitled*: "The classroom flip: using web course management tools to become the guide by the side".* The pioneers in the implementation and promotion of the model are two chemistry teachers in Colorado, Jonathan Bergmann and Aaron Sams, who recently (2012) published their book *"Flip Your Classroom: Reach Every Student in Every Class Every Day"* which is the most reliable guide for the implementation of the model. It starts with the realization that students need their teachers to respond to their questions and help them when they face difficulties, while they do not need to hear or watch a lecture. Thus, they collected the available material from the application of the model for interested teachers. Moreover, they founded the Flipped Learning Network community (FLN, 2014) (www.flippedlearning.org) providing modern information and helpful material for the application of the model.

The "flipped classroom" is a model of blended learning, in which students learn by watching videolectures or other educational material at home, while the "homework" is done in the classroom with the teacher and students discussing and resolving queries (Kandroudi & Bratitsis, 2013).

In traditional teaching students attend the "lecture" of the course and answer in tests at school, while they study the book and solve the exercises at home. In "flipped teaching" students study the next lesson at home on their own, usually through a video, which - at best-has been prepared by their teacher or other available material, and once they come in the classroom they apply their knowledge by solving problems and taking part in consolidation activities. The teacher supports the students exactly where they need. Its role is shifting from the traditional lecture to guidance, support and personalization (Bishop & Verleger, 2013).

For the implementation of the model, the use of an online educational platform is required and here comes the contribution of distance methodology and educational technology.

The reason we use and recommend this model is that the "flipped classroom" frees up valuable time for the acquisition of knowledge through problem solving and interaction of the students with each other, the teacher and the subject.

The use of video or other digital material outside class in itself is not enough for something to happen differently in the classroom. Emphasis should be placed on the fact that students are an active part of their own learning rather than teaching objects.

Moreover, Millenials' access to technology, information, and digital media is greater than that of any prior generation (Roehl et al, 2013), which is a parameter that is strongly considered through the "flipped classroom" implementation.

The Characteristics of the "Flipped Classroom" Model

There are four pillars that teachers must incorporate into their practice in order to engage with flipped learning (Pearson's School Achievement Services, 2013) (Fig.1):

- **F (Flexible Environment): Educators create flexible spaces in which students choose when and where they learn. They often physically rearrange their learning space to accommodate a lesson or unit and support either group work or independent study. Furthermore, educators who flip their classes are flexible in their expectations of student timelines for learning and in their assessments of student learning.**

- **L (Learning Culture): In the traditional teacher-centered model, the teacher is the primary source of information. By contrast, the Flipped Learning model deliberately shifts instruction to a learner-centered approach, wherein-class time is dedicated to exploring topics in greater depth and creating rich learning opportunities. As a result, students are actively involved in knowledge construction as they participate in and evaluate their learning in a manner that is personally meaningful.**
- **I (Intentional Content): Flipped Learning Educators continually think about how they can use the Flipped Learning model to help students develop conceptual understanding, as well as procedural fluency. They determine what they need to teach and what materials students should explore on their own. Educators use Intentional Content to maximize classroom time in order to adopt methods of student-centered, active learning strategies, depending on grade level and subject matter.**
- **P (Professional Educator): The role of a Professional Educator is even more important and often more demanding, in a Flipped Classroom than in a traditional one. During class time, educators continually observe their students, providing them with feedback relevant to that moment, and assessing their work. Professional Educators are reflective in their practice, connect with each other to improve their instruction, accept constructive criticism, and tolerate controlled chaos in their classrooms. While Professional Educators take on less visibly prominent roles in a flipped classroom, they remain the essential component that enables Flipped Learning to occur (Flipped Learning Network FLN, 2014).**

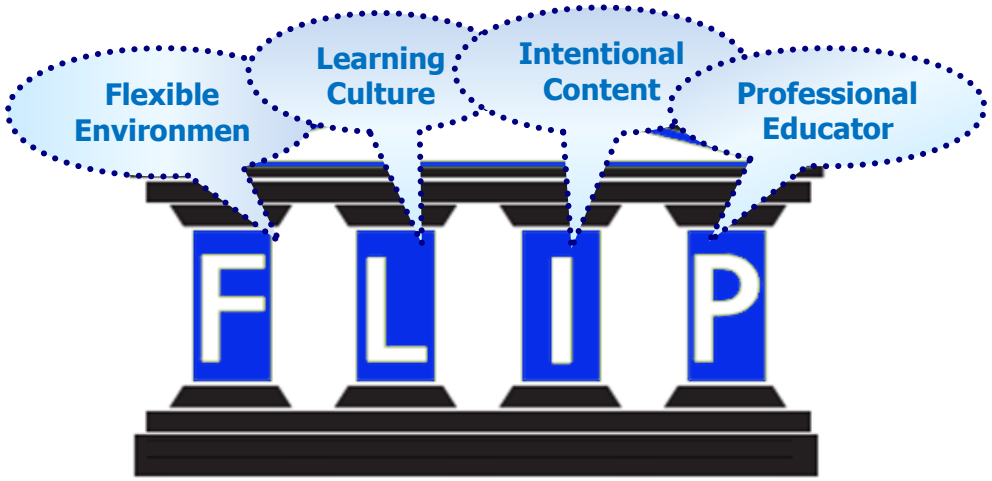

Figure 1. Pillars of "flipped classroom" (adapted from Hamdan et al., 2013)

Preparation and Implementation Stages

Estes et al. (2014) proposed a three-stage model to flip the classroom: the pre-class (modelling, pre-assessment), in-class (clarifying concepts, solving problems) and post-class (assessment, application, transfer) stages (Fig.2).

Figure 2. The stages of flipping a class (adapted from Estes et al., 2014)

The initial and final stages (pre and post class) were made by the students by distance, at home, using a digital platform and appropriate educational material. Students can view the digital content as many times as they want, they can focus on any points they wish, at their own space and their own pace (Strayer, 2007). Thus, the interaction of the students with the teaching material is scaled in a way that does not occur when lectures are given in class (Hertz, 2012). After the "flipped classroom" activities, students can return to the platform and check the level of their knowledge. Depending on their performance and after identifying their possible weaknesses, they can refer again to digital material, watch the video again –from a different viewpoint - or expand their knowledge further if they wish (Estes et al., 2014). The intermediate stage (in-class) takes place in the classroom, using active and participatory teaching techniques. In the "flipped classroom" students are asked to combine the information they acquired outside the classroom and interact with them and their peers in a way to show that they have become active users of information, based on their personal experiences, opportunities, critical thinking and interaction through group activities (Bergmann et al., 2011).

Expected Benefits from the Application of the "Flipped Classroom"

Based on the levels of taxonomy objectives in the cognitive domain of Bloom, in applying the "flipped classroom" model, lower levels – Remembering and Understanding – are achieved at home where students can study at their own pace (Fig.3). Higher levels- Applying, Analysing, Evaluating and Creating - are reached at school where the students have the support of the teacher and their classmates (Hamdan et al., 2013; Anderson & Krathwohl, 2001). One might reasonably expect the students to be able to learn, recall, and comprehend the subject matter at a basic level online - at home; then, use higher order thinking skills to apply, analyze, evaluate, and create new material in the synchronous classroom (flipped environment) (Estes et al., 2014).

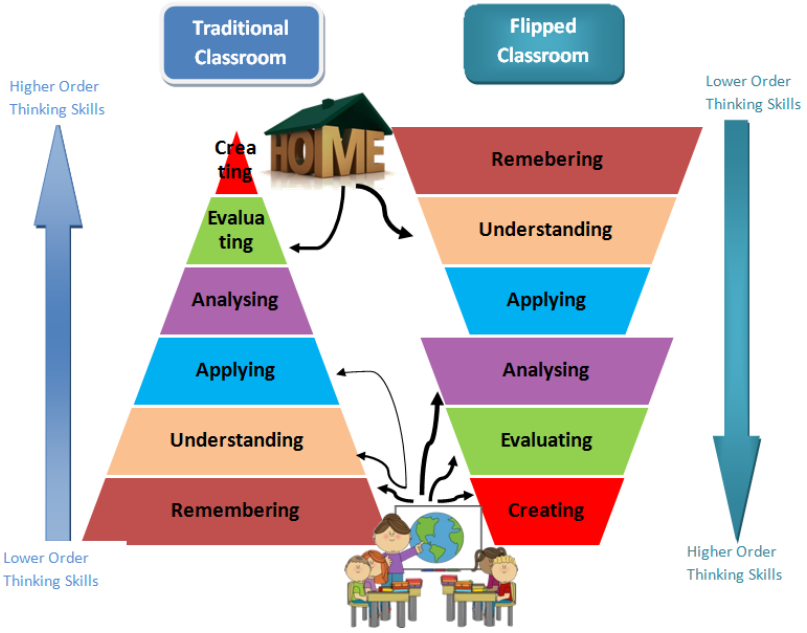

Figure 3. Improving learning to think in a flipping class

METHODOLOGY

We performed an action research implementing the "flipped classroom" in Biology teaching in a Greek junior high school. We studied the case of the model application in the classroom in the subject of Biology for the theme of "Photosynthesis".

Action research is developed through the spiral design cycles, action, observation and reflection. The starting point is a problematic situation, an issue of teachers' concern which needs ameliorating interventions (Altrrichter et al., 2001). This is a research method that is suitable for application in schools; it can be applied by teachers themselves ensuring the reliability of research results. The triangulation was achieved by collecting data from three "perspectives": the researcher, the pupils and a critical-friend-observer.

The educational platform used was the Learning Activity Management System (LAMS). The LAMS (http://lamsfoundation.org) is the most widespread and popular platform that implements the ideas of learning design (Dalziel, 2003; Britain, 2004).The LAMS is an Online Free Open Source Software (Papadakis, 2010; Papadakis & Paschalis, 2009) that supports the design, authoring, management and supervision of the execution of courses in the form of sequences of learning activities.

Action Research

The project was prepared at the beginning of the School Year 2014-2015, it was carried out in March 2015 in a 1st year class of the15th junior high school of Patras. The general plan of the implementation was the following:

- **Class selection -target group**
- **Information of the school advisor, parents and students**
- **Preparation of the educational material**
- **Familiarization of the students with the LAMS platform**
- **Application of the three stages (pre-class, in-class, post-class) of the flipping classroom with the attendance of a critical friend-observer.**

Target Group

The study concerned 17 students attending the 1st year of junior high school, 8 boys and 9 girls, presenting various performances (from very high to very low). It was a multi-cultural class, regarding the nationality of the pupils (12 were Greek and 5 foreigners: Albanians, Indians and Pakistanis). Four of them exhibited learning disabilities. The social-economic level of their parents was moderate. The sample was small, although as representative as possible. The findings were evaluated qualitative rather than quantitative, and can provide evidence about the prevailing situation.

Necessary Procedures before Applying Research

Information of the School Advisor, Parents and Students

The school advisor was informed in advance in order to give his permission for the implementation of the method. Furthermore, parents as well as students were straightened out about the methodology that was planned to follow.

An attempt was made to help students understand that they would combine face-to-face teaching with distance learning via computer activities (blended learning). In addition, they were told that the process would take part in a reversed order from the usual one (flipped classroom). It was made clear to the students that the aim of the procedure was not to assess their performance, but to evaluate the implementation of the flipped approach so it was absolutely necessary that they respond honestly to the various questions and not at random, so that research be driven to safe conclusions.

Preparing the Application - Creation of the Educational Material

The first and most important step concerned the creation of the proper educational material according to the distance educational principles. Given that students would be

invited to study alone, from home, at a distance from the school class, the educational material composed the main tool for their study. So it was necessary to know in detail from the first steps what to do, why they would do it, when to do it, how to do it and if they did it right (Lionarakis, 2001). The "Photosynthesis" unit was selected as the cognitive object to be taught, which -according to the curriculum- has to be taught in one hour. Moreover, because the students had no previous experience of the LAMS platform and in order for this not to affect the results, it was considered appropriate that a discrete course aimed at familiarizing students with the platform would precede.

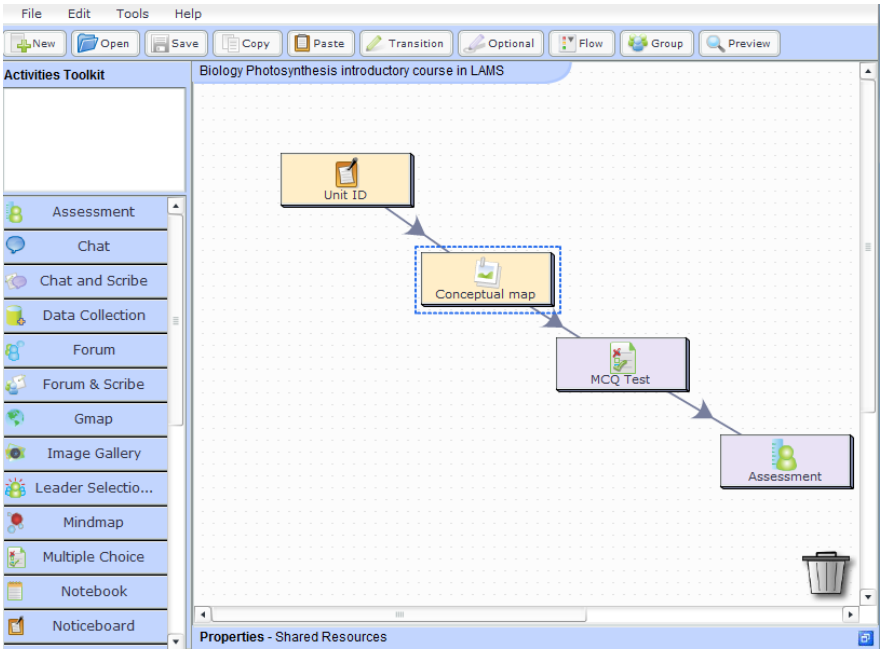

Figure 4. The learning sequence of the introductory course

So, a learning sequence was created in LAMS entitled "Acquaintance to the LAMS - Introduction" (Figure 4). We used the introductory section preceding the teaching of Photosynthesis which students had already learned in class. In this way, they focused on how to use the platform effectively. The course had the following simple structure and is posted online at: http://lamscommunity.org/lamscentral/sequence?seq_id=1986329.

The process involved a learning sequence of four steps as illustrated by the four rectangles of the above figure from the author environment. Specifically the students' environment included the following:

- **In the first step, the identity of the learning activity was determined.**
- **In the next step, there was a brief presentation of the lesson "Division of the organisms according to their eating habits" already taught to the students in the classroom. That lesson was the basis for the teaching of "Photosynthesis" which was the next section. Students were required to study a conceptual map and browse pop ups with information and images (Gariou, 2012a). At the same time, the various functions and features of the platform were explained, the difficulties were highlighted and their questions mainly on the use of the platform were resolved.**
- **The next two parts included questions on the subject of the next lesson "Photosynthesis". These were designed both in the context of better familiarity with the LAMS platform, but also in order to test the existing knowledge (pre-test) of students on the discipline of Photosynthesis, which would be taught using the "flipped classroom" methodology.**

This preparatory lesson was held at the Computer Lab of the school. The LAMS platform was presented to the students and they were provided with their passwords. It was figured out that the students interacted with the platform and familiarized themselves quite easily and pleasantly seeking new opportunities.

It's worth noting that the LAMS teachers' environment can support a wide range of pedagogical approaches, as well as the ability of authorship and supervision. The teacher can follow the progress of the students' studying and record statistics such as the time the learner spent on various sections, their performance on the various exercises and so on.

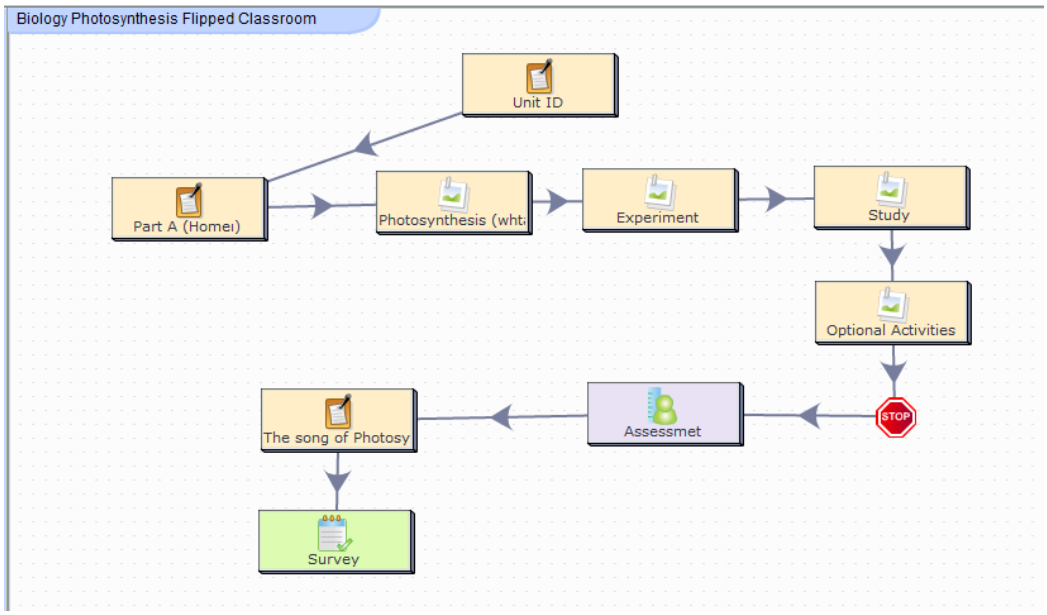

Figure 5. The design of learning activities of the "Photosynthesis – The Flipped Classroom" course

The main lesson (Figure 5) concerned the Unit of Photosynthesis and was carried out based on the principles of distance education and flipped learning. It was divided into three parts corresponding to the three steps of the "flipped classroom" implementation (pre-class, in-class, post-class).

a. **The first part was digital and it concerned the study of the students at home before the school class period. At this stage, students were required to study from home -on their own, at their own time and pace (distance education) - the following lesson, which is posted online at: http://lamscommunity.org/ lamscentral/sequence?seq_id=1986326 entitled "Photosynthesis – The Flipped Classroom" and included:**

   - **An introductory page of the section dealing.**
   - **A page with the objectives and expected results of the study.**
   - **Multimedia: A video presentation of the function of photosynthesis.**
   - **Practice: a videotaped experiment to demonstrate the importance of light in photosynthesis.**
   - **The relevant pages of the digital book for study.**
   - **An optional link of Wikipedia for further study.**

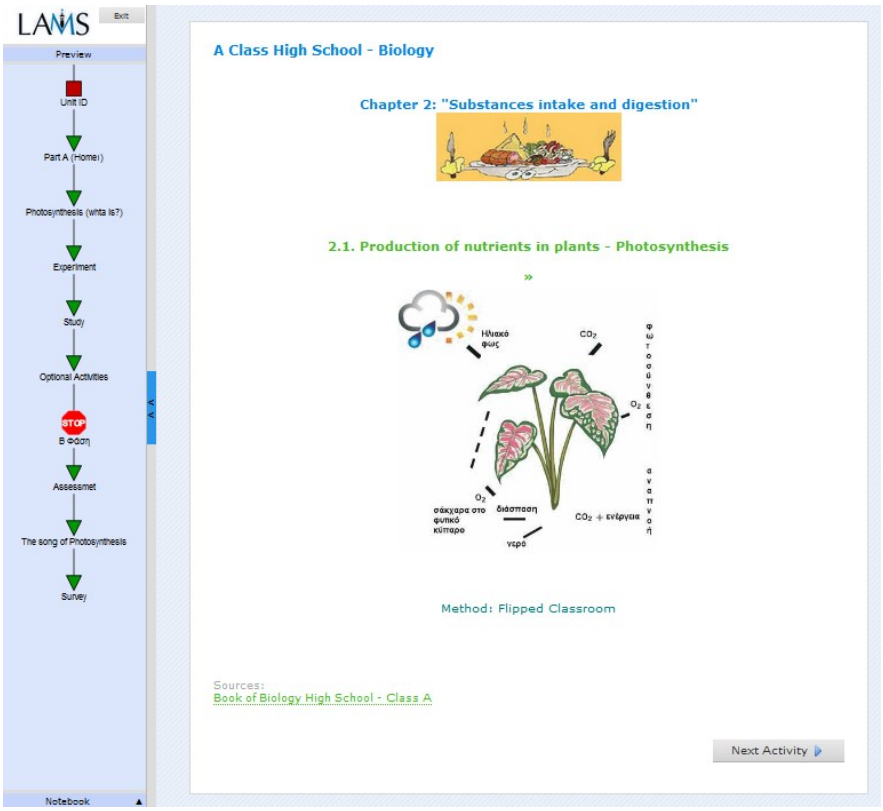

Figure 6. The introductory page of the section concerning the learner

At this point the distance study from home was completed. Students could repeat the whole lesson or whatever section they wished, but they could not go further. A gate (STOP) was placed and students were able to go on to the next level only when the author gave them permission. This could happen after the next phase was completed, that is the lesson in the classroom.

The video-presentation and experimental video material were created by the teacher herself and were posted in "Photodentro" (Gariou, 2012b; c). As shown in the literature (Bergmann et al., 2011) students prefer their teacher to talk in the digital material they are studying from home and so the corresponding learning objects were selected.

b. The second part took place in the classroom and involved teaching techniques and printed material supporting the active participation of the students in the social structure of the class and the efficient use of teaching time. At this stage, these students were invited to use the information they acquired "pre-class" and to interact with their peers by sharing the work traditionally done at home, in the social structure of the classroom.

The structure of the course in the classroom, in general, included: Starting point – ice breaking, brainstorming, questions-answers-discussion, team-working of two worksheets.

c. The third part was also digital and "unlocked" after the course was completed in class. This included:
- **A self-assessment exercise of knowledge acquired by students (post-test).**
- **A song for photosynthesis from the Internet for a pleasant ending of the lesson.**
- **A survey - questionnaire for the students to evaluate the process.**

RESULTS AND DISCUSSION

Pre-Class

Once the students familiarized themselves with the platform, they were given the address of the second lesson they had to study at home which was about "Photosynthesis", and they were asked to study it by themselves (on their own) using their codes before the next Biology class (four-day-period).

In this period we supervised the learning progress of the students. Wherever we detected students having difficulty with the course, we approached them at school for help. For example; some students who had already begun the lesson sequences, discontinued before finishing them. The teacher asked them questions, solved their own ones and encouraged them to continue. Some others did not even get into the platform. It was found that they had no access to a computer or the Internet at home. These students were given the permission to use the Computer Lab and they ran the lesson at school, each on their own, wearing a headset so that they were not affected by their classmates.
While monitoring the lesson, it was made clear that the amount of time every student devoted for every activity differed. Some students ran the lesson too fast. Some others spent a lot of time, repeating some of the activities. There were also students who spent a lot of time for the optional activity.

The above confirmed the need of the students to study at their own pace of progress each repeating what they had found necessary or pleasant and interesting as many times as they wanted. This is not easy to happen in the classroom and with the tight time limits of one class period.

What is more, it came to our attention that the interaction between the students and the educational material (presentation, video, book, external links) differed from one student to another, and it was also different among the various types of material. The optional link for more information in Wikipedia was the less popular among the students. The next less popular was the study of the e-book. The video-presentation and the experimental video had the most views by the students.

The many different types of the educational material and activities attracted the students and served many categories of educational purposes. It also promoted the independence and autonomy of the students, as well as the individualized learning, since the personal style of learning affected the educational outcome. Especially the experimental video strengthened the heuristic self-learning procedure, cultivated a scientific way of thinking and taught the meanings and the phenomena in an experiential way. Alongside with the video-presentation, they scored the highest viewing rate, which confirms that students prefer modern, interesting, interactive audiovisual material. Furthermore, both of these were accompanied with narration, also meeting the needs of students with learning disabilities.

Studies have shown that videos present a big advantage against a static image because they provide more information and they can make the deeper understanding of their content easier. Besides this, the content of the videos remains imprinted in memory for a longer period than a static image (Mayer, 2005; Jukes et al., 2010; Means et al., 2010).
The optional activity to gain more information about photosynthesis through the external link of Wikipedia presented the least number of visits. This fact, although at first glance it might seem negative, confirms that not all students are interested at the same level for every known object. But, giving the opportunity to the students who wanted, to go even deeper and be guided in this attempt is one of the strong points offered by the complementary school distance education. The optional activities have a great educational value, because they give students the opportunity to meet their interests, discover their abilities and tendencies and cultivate their personalities.

In-Class

Until the predetermined day of the "Flipped classroom", the teacher confirmed that all students had completed on their own the LAMS learning sequence given to them. The supervision of the digital lesson gave the opportunity to the teacher to watch the progress of each student as well as test the success rate of the questions from a distance. This was quite useful in order to design the course in the second phase of the methodology properly and prepare the grouping of students to work in the classroom collaboratively. Based on their answers to the pre-test, students were divided into 5 groups, each of which contained a highly scored and various other grades. On entering the classroom, students arranged their seats for team working according to the posted groups.

During this stage, a second teacher having the role of a critical friend-observer was present in the classroom. The second teacher didn't participate in the procedure, but wrote down his observations during the lesson according to the following list of axes that we were interested in. It should be noted that this teacher was highly qualified, having a Master's degree in the teaching of Chemistry. Indeed he was aware of the theoretical underpinnings of the methodology of the "flipped classroom" and he was very interested in taking part in this app. In addition, he taught to the specific pupils and so he knew them very well.

Observation Axes of a Critical Friend

- **Students' involvement and active participation in the educational process**
- **Students' cooperativeness and socialization**
- **Detection and dealing with the students' cognitive needs**
- **Use of a variety of teaching techniques**
- **Efficiency of the educational design**
- **Strengthening students' confidence**
- **Utilization of teaching time**
- **Possibility of deepening into the cognitive subject**
- **Compatibility with the official curriculum of study**

Inside the classroom, a wide range of teaching techniques was used in order to optimize the given teaching time and activate the students' involvement. Students' engagement was indeed noted during all the phases of the lesson. Probably, the fact that pupils were already prepared for the content of the following lesson contributed to this. Students asked each other, explained, commented, communicated, conferred, supported, compared, replied, thus contributing to the effective learning.

Despite that, many false preconceptions were stated during the presentation of the first work sheet. Although they had studied the lesson on their own, most of the students didn't seem to have changed their misconceptions about the process of Photosynthesis. The discussion among the students in the classroom led to the detection of the errors and the expression the correct options. The teacher's role was shifted to distinctive feedback, encouragement and support.

With the completion of all group presentations, it was noted that there was excess of time! Given the academic background of the "flipped classroom" we had been prepared for such a possibility, and thus we distributed another work-sheet to the students concerning the experimental video they had watched at home. The answers were this time much clearer and correct. This is maybe due to the students' active involvement during the previous classroom time, or/and to the fact that the experimental video attracted their attention.

The experimental procedures, even when presented videotaped, stirred the interest of the students, which was consistent with the high viewing rate of the activity of the digital course of LAMS. Besides, the laboratory experimentation is central to learning science (Toth et al., 2008). Through its utilization conceptual understanding is activated and

promoted, knowledge is built and learning is enriched as connected to the real world. Moreover, in the videotaped environment, students were able to observe a phenomenon in a shorter time than the actual time span and become familiar with the way that scientists experiment in science.

Post-Class

The third stage took place at home, from a distance and had to do with a self-evaluation test and a survey on the methodology followed. From the pre- test it was observed that the students had a limited knowledge (low base) on Photosynthesis The post-test presented an improvement in the students' performance. So, it appeared that the methodology had a positive effect on the cognitive level of the students, after some improvement in the number of correct answers given (Fig. 7).

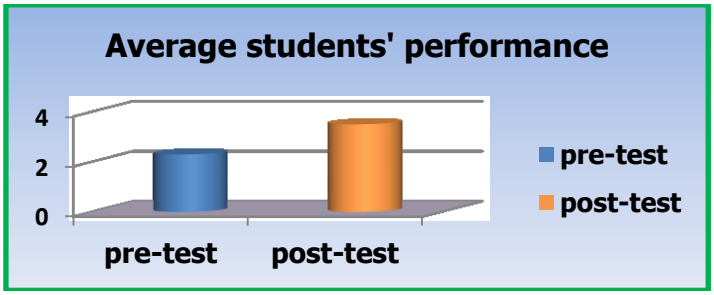

Figure 7. Average students' performance at pre and post - test

Investigation of the Students' Opinion (Survey)

Research into students' opinion on the application of the "flipped classroom" methodology generally showed their acceptance of the new didactic proposal. The LAMS environment as well as the digital content aroused their interest in the study. Students also favoured a combination of "flipped" and traditional ways for their study. They responded positively to the content of the lesson and to the technical requirements of the digital material. The digital environment of the LAMS' platform is designed to facilitate and guide the distance learner on his way to the acquisition of knowledge.

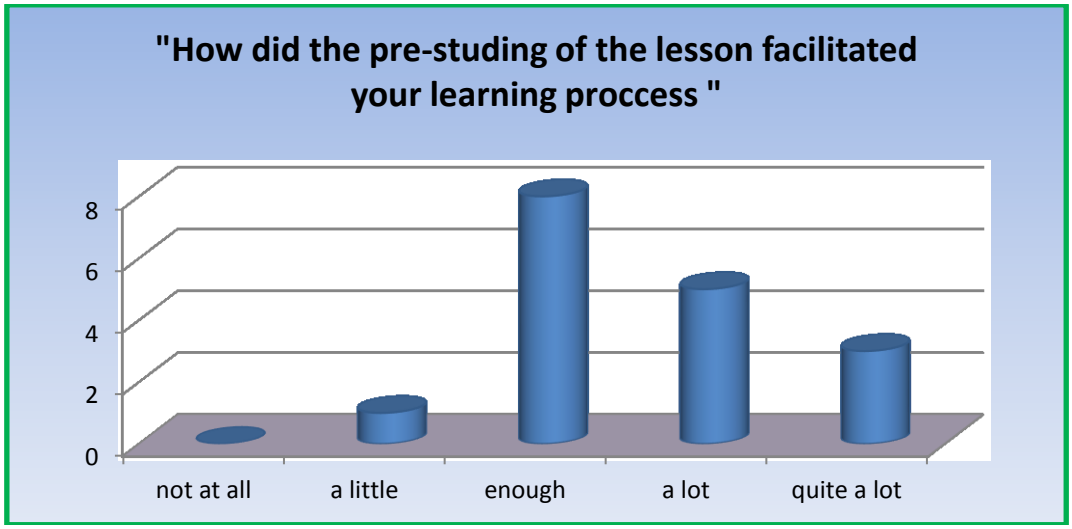

Figure 8. Students' opinion on the implementation of the "*Flipped classroom*"

Overall, students appeared satisfied with the implementation of the "Flipped classroom" (fig.8), found the lesson pleasant and expressed the desire to be taught with this methodology in further subjects, as shown below by their comments:

"LAMS helped us immensely and helped us solve our problems and answer questions"
"I really liked the lesson. It helped me answer some questions"
"I would like to do all the lessons in this way"
"Let's do all the courses in this way (except art, gymnastics and music)"
"It's interesting to make a preparation for the lesson at school, then at home read the lesson and the digital material and then do the exercises at school"

Findings from the Critical Friend

The critical friend gave a more objective aspect of the classroom function and contributed to the extraction and evaluation of the study (consideration, reflection).

Generally, criticism of the friend-observer was positive and optimistic concerning the pedagogical, the cognitive as well as the emotional level. The possibilities of better time management and more efficient educational design were pointed out based on the targeting, the quality and the number of activities accomplished in the classroom. Furthermore, students' active involvement in the educational process led to their taking action and initiative and finally to active learning.

Students' persistence on their pre-existing perceptions –despite studying at home- was highlighted as the negative element. The possibility of monitoring (supervision) given by the LAMS environment as well as the finest time management in the classroom contributed to effectively coping with this issue.

CONCLUSIONS

A general conclusion of this study which can be reached is that it is possible to make good use of the "flipped classroom" methodology as a complementary tool to school distance education in junior high school Biology.

The following elements of the "flipped classroom" that contribute to the optimization of the learning process were noticed:

- **The implementation of the "flipped classroom" had a great effect on time management. Students watched the following lesson away from class, from a distance, on their own thus giving free time for targeted, constructive activities, troubleshooting, and detection of tricky meanings in the class under the guidance of the teacher.**
- **There was efficient detection and dealing with the students' cognitive needs due to the fruitful educational design. The methodology required the use of an online digital platform. LAMS environment was selected due to the diversity of pedagogical tools that it provided to the authors.**
- **The use of polymorphic educational material that was prepared for home study and for classwork led students to taking action and initiative and finally to their active learning.**
- **The students' attitude towards the use of ICT was positive, being quite capable of handling digital files, although it was the first time that they used such a platform. They expressed their desire to attend more lessons using similar tools.**
- **Moreover, the "flipped classroom" methodology enabled those students who wish to study a specific subject more deeply. This is one of the strong features of the methodology which teachers can use in order to satisfy their students' personalized interests –something that can hardly occur in a traditional class.**
- **Students' involvement and active participation in the educational process were remarkably increased. Students knew that their teacher was monitoring (supervising) their progress while they attended the lesson at home. So, they were already familiar with the cognitive aspect of the lesson before entering the school class. As a consequence, pupils entered the class with less stress and higher confidence. They were involved more easily in co-operative and**

discovering activities and they considered the learning process a personal affair which did not only depend on the teacher. Finally, they obtained a more positive view towards Biology.

- **It is worth mentioning that students exhibiting learning disabilities revealed a peculiar interest concerning the use of digital tools and participated sufficiently in the distance study as well as in the in-class activities. Although this group was not a separate objective in our work, the positive effect of the "flipped classroom" methodology gave an added value to the results of this research.**

There were some difficulties that we faced when we applied the "flipped classroom" method in a Biology class:

- **Despite attending the following lesson before entering the class, most of the students did not change their pre-existing concepts which we recorded though the pre-test. Studying at home, from a distance, was not enough alone to lead to a cognitive conflict. To accurately record the situation we suggest that during a future application - in addition to the pre- test (initial assessment) and the post-test (final evaluation) –there be a knowledge control to be inserted immediately after the (distant) home preparation or prior to the conduct of the lesson in the classroom (formative evaluation).This will give more accurate information about what students were able to learn studying on their own, at their own pace and in their own time at home.**

On the other hand, the aim of the implementation of the "flipped classroom" was not to leave pupils alone to learn from a distance, but to optimize time management and students' involvement in the class. This target was fully successful based on their active learning and the results of the post-test.

- **Secondly, we have to note that the implementation of the "flipped classroom" demands more time and effort in order for the teacher to prepare the lesson. The distance, online parts of the lesson need to be digital, polymorphic and attractive, while the in-class part ought to be focused on the individual learning needs of the students.**

This difficulty can be overcome given that these lessons are re-usable and can be distributed along the educational community. During one school year, a teacher could create one or two "flipped" lessons, which he subsequently shares with the learning community, such as the LAMS community. In this way, one lesson can be reusable, adaptable, versatile and free-offered to the modern, globalized society as a part of open educational resources.

RECOMMENDATIONS

During the implementation of this research new questions that could be investigated in the future arose.

In order to extract more reliable conclusions, it would be suggested the "flipped classroom" be applied at a larger scale. That is one course during a quarter or a semester or the whole school year, or even many different courses or classes of the same or different scholar units including elementary, secondary, high school, general or vocational. Feedback could lead to the improvement of the implementation.

It would be of interest to investigate more specialized markers, such as the impact of the "flipped classroom" on the students' performance, its influence on the levels of stress, its effect on the satisfaction they gain from their involvement, or even on groups of students with different learning abilities.

Another factor that could be considered is the potential of improving the distance part of students" studying. In case we realized that watching a video or other educational material from a distance is not efficient enough to learn, one could explore whether this

could become more productive if it were combined with other techniques. For instance, students could be obliged to submit questions to the digital platform or hold notes, or draft a summary following the watched presentation. These techniques might motivate students to familiarize themselves with the content of the educational material rather than remain passive recipients. Making a deal regarding the students' obligations mentioned above could lead to their considering the learning process a personal individual affair. The addition of a questionnaire following the pre-class stage would contribute to the focusing of the students on the cognitive subject as well as the optimal educational design.

All in all, the role that school plays cannot be questioned or replaced. School distance education combined with the radical development of ICT can be complementary with the use of various methods, like the "flipped learning", and gives a new perspective and potential to the limited choices of conventional education in the Greek educational system which is worth further investigation.

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BIODATA and CONTACT ADDRESSES of the AUTHORS

Dr. Angeliki GARIOU-PAPALEXIOU is a high school director in Patras, Greece. She holds a PhD in Biology (University of Patras) and a master degree in Education (Hellenic Open University). Her research interests include Biology (Insect Cytogenetics) as well as Educational Technologies. She teaches Natural Sciences in secondary school. She is a certified teacher trainer in the utilization and application of ICTs in the teaching practice at an advanced level. She has contributed to the creation of many digital learning objects in Biology at Photodentro repository of Greek Digital School (http://photodentro.edu.gr/). She has been occupied as a contract lecturer (PD407/1980) in the dept. of Primary Education in the University of Patras and is a collaborator researcher in the Biology Dept. of the University of Patras.

Dr. Angeliki GARIOU-PAPALEXIOU
150 Gymnasium of Patras, 26443 Patras, Greece
Phone: +30 6973032448,
Email: gariou@sch.gr, gariou@upatras.gr

Dr. Spyros PAPADAKIS is Director of Regional Training Center of Patras and School Councelor / Advisor for Computer Science Teachers in Western Greece, Ministry of Education, Research and Religious Affairs in Greece and part-time Adjunct Faculty (Tutor-Counselor) Hellenic Open University (HOU), & Open University of Cyprus (OUC). His current research interests include the utilization of educational technologies in K-12, learning design, the design of computer-enhanced curricula, the design and evaluation of web based and mobile learning technologies, adult education, teachers training, teaching and learning in virtual and blended learning environments. He has extensive teaching experience as teacher and lecturer in the schools sector teaching Computer Science and Adult Education from secondary to higher and professional development. He has participated in 30 research and development projects in the area of software engineering and educational technologies.

Dr. Spyros PAPADAKIS
13-15 Epirou 19-21, GR26223 Patras, Greece
Phone: +30 695 782 1227,
Email: papadakis@eap.gr

Dr. Evangelia (Gelly) MANOUSOU has done postgraduate studies in Educational Informatics and holds a Ph.D. in Distance Learning Education. She is currently working as headmaster of primary school as well as a tutor supervisor at the Hellenic Open University. She has trained teachers in many subjects for more than 600 hours on behalf of the Ministry of Education. She has participated in Grundvich projects. She was in charge of Environmental Education for the Prefecture of the Cyclades Islands as a member of the Pedagogical Institute. She has written a great variety of pedagogical material and articles, she has participated in several research projects and is a regular collaborator in the journal: «Window to Education» and "Window Junior" in subjects related to the environmental and health-oriented activities. She participates actively in many environmental and cultural, nongovernmental organizations.

Dr. Evangelia (Gelly) MANOUSOU
Paradeisou 23, 17123 Nea Smirni, Athens, Greece
Phone: +30 6947723139,
Email: manousoug@gmail.com

Dr. Irene GEORGIADU is a graduate of the Chemistry Department of the University of Patras and owner of a PhD from the same Department. She also has a master on the training of adults in Open and Distance Education. She is a Professor, Tutor and Adviser of the Hellenic Open University for 15 years, from the beginning of the Institution. She has 11 publications in international magazines with judge, 16 seminars of national conferences and 4 participations in national conferences. She has also been a judge of proposals in the 2nd, 3rd, 4th, 5th 6th, 7th and 8th Conference of Open and Distance Education of HOU. She can speak English and has a good knowledge of informatics.

Dr. Irene GEORGIADU
Haralambi 93, 26224 Patras, GREECE
Phone: +30 2610335012,
Email: georgiadu@yahoo.gr

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