Blended Methods to Enhance Learning: An Empirical Study of Factors Affecting Student Participation in the use of e-Tools to Complement F2F Teaching of Algorithms

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Abstract: Our research aims to improve the quality of academic studies in Universities. Specifically, we aim at the adaptation of blended learning strategies, use of digital media (computer, internet) and e-learning methods. In this paper we investigate the factors affecting first year students, in using e-learning methods in conventional Higher Education. Nowadays, an interesting research question, which has been raised, is related to the effective use of blended learning techniques complementary to f2f teaching in conventional Higher Education. The scientific contribution of the proposed paper is the presentation of some new results on the students' perceptions regarding the above question. We believe that our findings constitute a first step towards to this direction. Our empirical study is based on questionnaires and interviews, which include quantitative and qualitative topics. The research took place during the first semester compulsory course "Algorithms with C", in the department of Applied Informatics, University of Macedonia, Thessaloniki, Greece. The students' use of e-tools was investigated and the results are thoroughly described. In this research, special concentration was given on learning difficulties in fundamental algorithmic concepts. Moreover, the level of students' adaptation of web-based and distance education methods, as a complementary tool in face-to-face (*f2f*) teaching of algorithms, was studied. Particularly, we focus on the factors which affected in discouraging students from the use of multiple web-based tools. Additionally, we investigate the students' expectations and attitudes, based on their experience, in using synchronous and asynchronous state-of-the-art e-tools such as LMS-CoMPUs, virtual classrooms, webcasts and educational games.

Keywords: Blended learning, algorithms, e-Learning, Higher education

1. Introduction

Higher Education turns to blended learning and this is recognized as one of the greatest trends in education and training today (Drossos et al. 2006). The traditional *face-to-face* (f2f) classroom environment has been in use for centuries but web-based learning environments expanded in exponential ways. Complementing traditional teaching with blended learning techniques in a traditional University course, presents a variety of challenges. The support of teaching and learning with e-tools provides the opportunity to customize students' learning according to their educational needs, something difficult to implement in traditional education.

The main aim of blended courses is to combine the best features of in-classroom teaching with the best features of e-learning. Using e-Learning technologies, instructors implement a blended model and redesign some lectures into new online learning activities, such as tutorials, self-testing exercises, and online group collaborations. We experimented with an e-learning approach from distance as complementary tool in traditional f2f classroom instruction. Our motivation for this experiment was the students' *low pass rate* in exams of the compulsory course "Algorithms with C" in the Department of Applied Informatics, University of Macedonia, Thessaloniki, Greece. We did not substitute part of f2f lectures with online teaching but instead, we used e-teaching additionally to the traditional teaching of the course. It is well known that e-learning can be very effective at the traditional classroom level with activities such as library search or teamwork. On the other hand, the main drawback is the need of computers in the class, whereas the conventional classrooms (not laboratories) lack of computers. Also, there is neither students' time availability to attend additional tutorials at the University, nor classrooms or instructors for implementing them.

Our main research question, which has been raised, is related to the effective use of blended learning techniques complementary to f2f teaching in conventional Higher Education. In order to investigate this, our research questions for the study were set as follows:

- What are the most important difficulties that students faced up during their studies of algorithms?
- What are the factors affecting students' participation in using the available e-tools during the whole semester? Particularly, which were the factors affecting their participation in synchronous (virtual class, educational game) and asynchronous e-tools (webcasts, forum)?
- What are students' perceptions and attitudes about the ability of e-tools use and blended methods to enhance learning?
- Which are students' expectations from using e-tools during their studies?

This paper is organized as follows: firstly, an overview of blended learning and a short review on available synchronous and asynchronous e-tools are given. Students' perceptions in blended teaching implementation in Higher Education are briefly provided. Secondly, our findings of an empirical study using e-tools and blended learning techniques in teaching are described. To end with, the results of using e-learning techniques as a supplementary tool in traditional education are discussed and conclusions are drawn.

2. Literature review

It is clear from the literature that blended learning environments are recognized as an important dimension of Higher Education (Graham et al. 2003). While blended learning environments is a combination of traditional f2f learning and e-learning, it is not enough to simply mix the research literature from these two different areas of learning in order to develop a blended learning model. An increased and continuing effort should be done to effectively design blended learning experiences for both instructors and students. Blended courses have hybrid format, i.e. f2f and e-learning are combined either additionally or complementary.

2.1 What is blended learning?

Hybrid/blended learning is not a novel nicety, but increasingly becoming an essential mode of delivering instruction (Koohang et al., 2006). Nowadays, many universities are adopting *hybrid learning (*Young, 2002). The terms "hybrid learning" and "blended learning" are often used interchangeably. Hybrid learning is a blend or mix of conventional face-to-face (f2f) instruction and Web-based distance learning (Koohang & Durante, 2003). The terms *Blended learning* (BL) or *hybrid instruction*s are commonly used to label courses that combine f2f classroom instruction with online instruction (Brown, 2001; Young, 2002). In "hybrid" classes, a significant amount of the course learning activity has been moved online, making it possible to reduce the amount of time spent in the classroom. Traditional f2f instruction is reduced but not eliminated. Similarly, a blended learning course (in RIT) is defined as any course where online instructor-guided activities are used to replace 25 to 50 percent of classroom lectures and other seat time (Figure 1).The goal of hybrid courses is to join the best features of f2f teaching with the best features of online learning to promote active independent learning and reduce class seat time. The most critical variable in hybrid/blended learning should be student learning. The design of hybrid/blended learning value rests with sound and appropriate instructional design (Koohang & Durante, 2003). *Blended learning* environments aim to combine attributes of online instruction (efficiency, sufficiency, freedom to access information anytime with minimal effort), with attributes of traditional classroom instruction (enabling students to work with the new information presented, as well as interact with peers and the teacher in the classroom) (Delialioglu & Yildirim 2007). Nowadays, the term *Blended Learning* (BL) has gained considerable currency as a description of particular forms of teaching with technology.

However, this term remains ill-defined as Oliver and Trigwell (2005) say. Between the various given definitions are combinations of: a) benefits of traditional instructor led training with the advantages brought by a variety of technologies to create an optimum program (Alvarez 2005), b) online learning, f2f learning and self-paced interactions among instructors, students and the instructional system (Choi 2004), c) instructional methods (Driscoll 2002) d) traditional learning with web-based online approaches or media and tools employed in an e-learning environment or a number of pedagogic approaches, irrespective of learning technology use (Whitelock & Jelfs 2003), e) different modes of delivery, models of teaching and styles of learning (Procter, 2003). Hoffman

(2001) denotes that "the idea behind BL is that instructional designers review a learning program, chunk it into modules and determines the best medium to deliver those modules to the learner". Valiathan (2002) refers that BL describes "a solution that combines several different delivery methods, such as collaboration software, Web-based courses, Electronic Performance Support Systems and knowledge management practices".

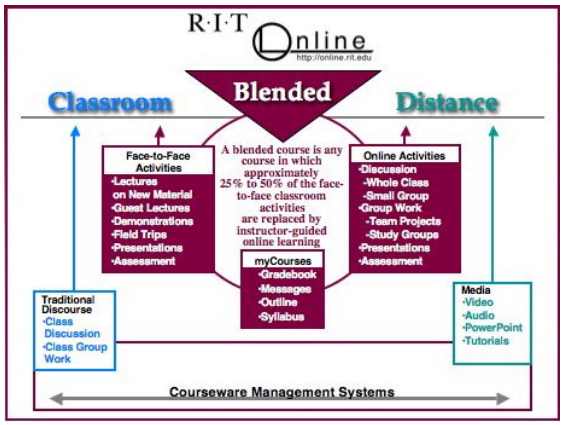


Figure1: Blended learning course in RIT (http://online.rit.edu)

BL focuses on optimizing achievement of learning objectives by applying the "right" learning technologies to match the "right" personal learning style to transfer the "right" skills to the "right" person at the "right" time. (Singh & Reed 2001). BL is the convergence of two archetypal learning environments. On the one hand, we have the traditional f2f learning environment that has been around for centuries. On the other hand, we have distributed learning environments that expanded in exponential ways as new technologies have expanded the possibilities for distance communication and interaction. We agree with the definition of *BL as a combination of online and f2f instruction* (Sands 2002; Ward & LaBranche 2003; Young 2002) and we add *that BL integrates the combination of f2f and online teaching in order to maximize both f2f and online modes of instruction, and is implemented as a complementary tool to traditional teaching.*

2.2 What are students' perceptions in blended learning implementation?

Delioglou and Yildirim (2007) in their investigation found that the majority of the students indicated their enjoyment in taking a hybrid course after so many traditional courses and found interaction with the instructor especially motivating. They stated that they prefer doing activities rather than sitting silently and listening to the instructor. According to Weaver's research (2005) some of the main motivators for student participation are the ability to learn from others by gaining opinions, advice or responses from others and giving or receiving help from moderators. She also identifies some demotivators i.e. access, technology and forum layout problems, time pressure, irrelevant discussion topics, many postings, non-participation by others, fear of looking silly and lack of confidence. Gerbic (2006) refers that factors affecting students' participation in online discussions related to access to technology at home, lack of familiarity with computers or the software, technical problems, lack of participation, too much information and easier expressing thoughts in text rather than speech. As it concerns the educational interaction, the literature suggests some factors that could affect participation. Some of them are *the text-based chat medium* which displays rapid speed of discussion *(*Dykes & Schwier 2003)*, the design of instructional activity* which includes mandated participation in assessed instructional activities *(*Sudweeks & Simoff 2000), tutor facilitation style (Cox et al. 2004, Kneser et al. 2001) and student moderation style (Chou 2002), and *participant characteristics* which encompass prior experience with the chat medium and its linguistic conventions (Murphy & Collins 1997) and gender (Chou 2002).

Lim and Sudweeks (2006) findings on student perceptions of participation opportunities in online synchronous tutorials, revealed common factors that motivated and inhibited participation. These factors are *presenter role,* the *tutor facilitation style,* the *tutor assessment* of participation, which encouraged more activity and *turn-taking behaviour,* which indicated greater tendencies towards making early and additional contributions to discussions. Also, the synchronous tutorial was found

to encourage expression of views, provided a novel learning experience generating greater collaborative efforts and students felt more confident than in f2f tutorial.

2.3 Synchronous and asynchronous e-learning tools

BL is usually hosted by a *Learning Management System* (LMS) that supports the lifecycle activities. A LMS is a software application based on internet technologies that support management and delivery of distance learning content and services. The use of LMS in education offers certain advantages since it overcomes time and space constraints, offers flexibility in learning methods and supports extensive interaction between teachers and students. Also, it allows inexpensive management and modification of learning resources (Prodromou & Avouris 2006). *CoMPUs* platform is a complete system of Asynchronous Tele-Education of University of Macedonia, Greece (http://compus.uom.gr/index.php). Apart from LMS, *webcasts* can support BL asynchronously. webcasts combine a series of "transparencies" with narrative and simple video (mostly the speaker) (Papadakis & Hadzilacos 2005). *Virtual Classroom* Live eLearning or Synchronous eLearning is a group of students gathered together online at a certain time, for a certain duration and students are in different places and are taught electronically by a teacher using a web browser with integrated voice and video as the main delivery medium. As the sessions are recorded, the learning module can be both synchronous and asynchronous. It can be replayed for clarification and reinforcement (Keegan et al. 2005). *Centra* is an online learning environment with virtual classroom interaction. It is a set of features for interactive, effective group learning, bringing together voice, video, data and graphics in a structured online learning environment (www.centra.com). *Educational Game* is a computer-assisted instruction technique in which skill and chance are combined for practice of previously taught information. *Savie's online Educational Games Central (EGC)* was designed as a virtual meeting-place for those interested in using games for educational purposes. Teachers can choose between either using predefined available games or creating new games from scratch (www.savie.qc.ca/carrefourjeux2)

3. Research Methodology

In Higher Education the most common way of teaching practice is still focused on transmissive rather than interactive strategies to support learning. In order to support our students' studying we piloted blended approach during the first semester compulsory course "Algorithms with C", during the academic year 2006-2007 and 33 students participated (voluntarily) in asynchronous and synchronous teaching in parallel to traditional one. The main aim of the blended approach was students' support during the whole semester with the use of e-learning tools (Papadakis et al. 2006). The reasons of supporting students with methods of distance education, especially with blended approach are: the weakness of additional hours of (traditional) teaching, the lack of possibility of f2f tutorials at the university, the lack of available students' time for attending additional lessons and the difficulty of synchronization between students' individual study and lectures. We used synchronous and asynchronous e-tools to help students in achieving the educational goals. Online learning did not replace some f2f time or classroom activities and e-Learning part becomes a natural extension of traditional classroom learning. Our teaching process included various media, such as: traditional 2 hours per week f2f teaching, stand-alone web-based learning (studying educational material on CoMPUs), asynchronous web-based teaching (forum of CoMPUs and webcasts) and synchronous web-based teaching (virtual classroom, educational games). Real time events like virtual classrooms featured this teaching approach. During virtual classrooms students could interact through posting email questions or forum discussion or communicate in real time in collaborative activities. The content of the lecture during the virtual classrooms was fluid and dynamic as it was largely determined by the individual and group activities. The tutor's role was more extensive than that in the traditional teaching, because only some of the guidelines of the course were pre-determined and most of them were created each time the course was taught, through discussions and activities.

The e-tools which we used were: LMS CoMPUs, Webcast Producer for video lectures, Centra Symposium for virtual classrooms and EGC for educational games.

3.1 Data collection

We conducted our empirical study with two data collection methods. Firstly, a questionnaire was delivered to all students of the course and secondly a semi-structured interview with participants in blended course. Both of them were implemented at the end of the course and included quantitative and qualitative topics. The purpose of the combination (survey – interview) was to gain a better understanding of students' learning preferences for their studying support in relation to on-line and classroom enhanced environments, in order to redesign the learning environment according to their learning needs. To be more precise, at the end of the semester a more than 50-items survey was administered to 187 first year students of the course during the final examination. The survey instrument had a 98% return rate. More data were elicited from the focus group (33 students) with an interview which contained open-ended questions asking students to verbalize about their learning experience and preferences, their support from f2f and on-line combination and the impact of it on their learning. It was an investigation of their experiences and attitudes for the utilization of tele-education methods as an additional tool in the traditional higher education. They are followed findings on *difficulties* that students faced up during their studies, *factors* promoting their participation or abstention in using e-tools, *students' perceptions and attitudes* about the ability of e-tools use and blended methods to enhance learning and *students' expectations* from their participation.

3.2 Participants

In our empirical study participants were 183 of 187 students enrolled in the "Algorithms with C" course. The study lasted 14 weeks and during this period all students could attend 2 hours f2f class. The course was designed and offered as a blended course and 33 students participated voluntarily.

3.3 Empirical study results

The data collected in the survey provided background information about the students' gender, level of education and internet access. The data revealed that over 55% of the students were male and predominantly (66%) first year students. Based on the students' feedback, a short statistical analysis was carried out, in order to clarify the benefits or the drawbacks of BL teaching approach. They are described the most important difficulties that students faced up during their studies and their perceptions in use of e-tools complementary to f2f teaching of Algorithms. Furthermore, the students' participation and expectations from using e-tools during their studies are examined. In order to present the most important results of the questionnaire, some questions were selected.

4. Findings

In this subsection, we present our findings about the factors affecting first year students, in using e-learning methods in conventional Higher Education. The students' participation in webcasts, forum, virtual classrooms and educational games is studied. Some questions refer both to difficulties on algorithmic topics and factors affecting their participation or abstention in asynchronous and synchronous e-tools. Specifically, we are interested in finding if the difficulties in algorithms refer to understanding the pseudo-code or pre-solved examples, or implementing the algorithm. Also we investigate the reasons of the small participation in the course forum for instance the easiness of the course, the difficult use of the forum, the lack of self-study during the whole semester, the need of more encouragement – stimulation and/or the feel of embarrassment or eponymic participation.
As it concerns the difficulties that students faced up during their study of algorithms, the half of them found more difficulties in the pseudo–code understanding (49,33%) and/or in the algorithm implementation (40,36%) and few (6,28%) found more difficulties reading pre-solved examples (Figure 2).

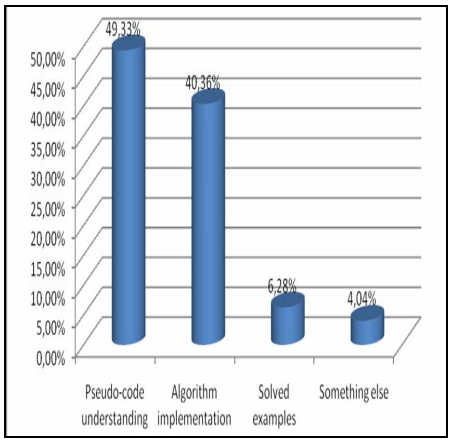
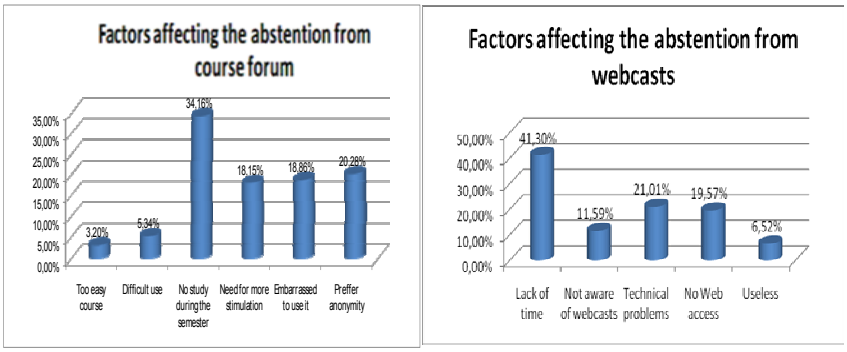


Figure 2: Students' difficulties in Algorithms topics

The available asynchronous e-tools during the whole semester were webcasts and the forum of the course where students could pose their queries and difficulties but there was not high participation in them. The majority of the students explained that the reason of their abstention was the lack of study during the semester (34,16%). A significant number of students (20,28%) preferred to keep anonymity and therefore they didn't feel comfortable in using it (Figure 3a). Similarly, the most of the students (41,30%) mentioned that they couldn't find spare time for attending the webcasts. Moreover, many students (21,01%) faced several technical problems either with software applications or with their hardware (Figure 3b).



(a) (b)

Figure 3: Students' abstention from asynchronous e-tools use: a) forum and b) webcasts

As in the case of webcasts, many students (30,41%) did not participate in virtual classroom due to lack of available time or hard self- study (23,20%) during the semester (Figure 4). Only few students (1,03%) considered that the reason of abstention is the easiness of the course.

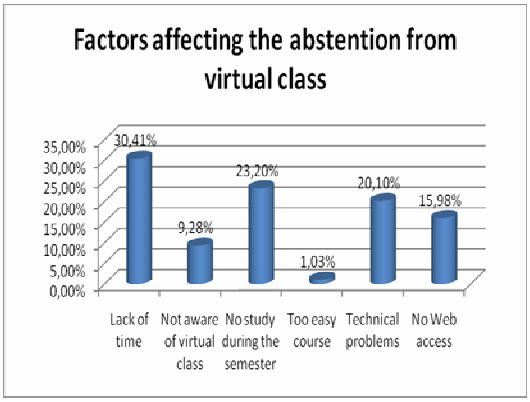


Figure 4: Factors affecting students' abstention from virtual class

Finally, the majority of the students (39,42%) who did not *play* couldn't devote some time for it. Also, there were many students (29,93%) who weren't aware of this type of activity, although all the available e-tools used in blended course were equally announced in CoMPUs (Figure 6).

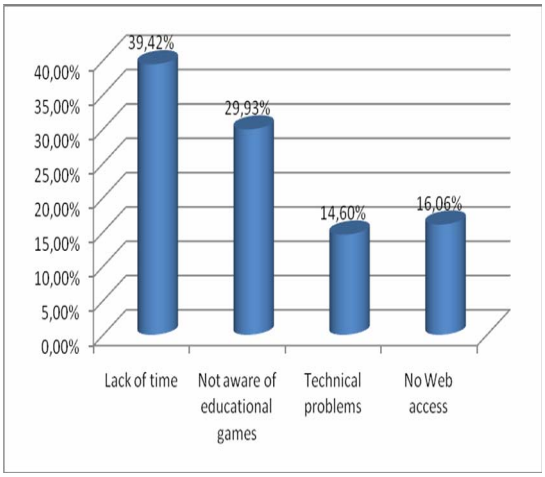


Figure 5: Factors affecting students' abstention from "playing" the available educational games

To end with, *players-students* were more interested in playing the available algorithm educational games in *distributed mode*, about either recursiveness (36,17%) or sorting (25,53%), rather than playing in *local mode* (Figure 6).

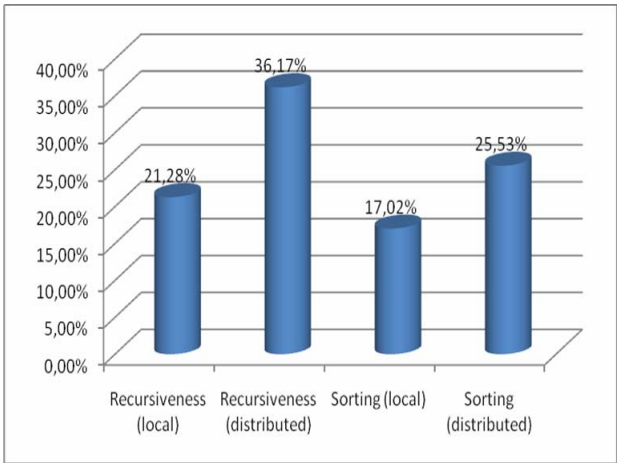
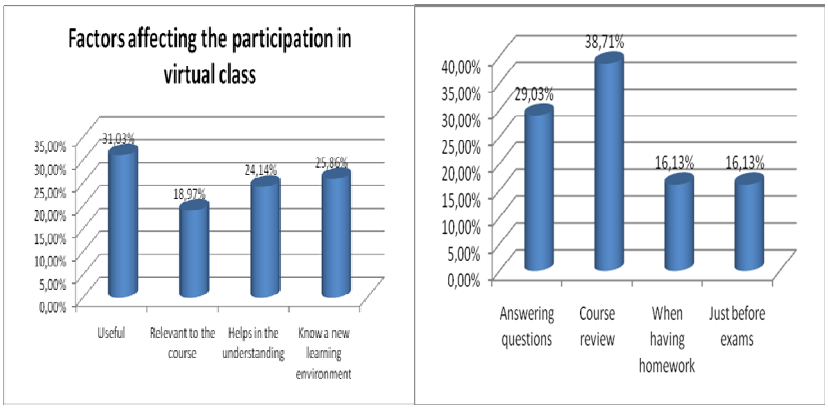


Figure 6: Students' preferences on "playing" algorithmic educational games

Better insight, about students' perceptions and attitudes revealed from a semi-structured interview at the end of the course where students expressed their motivations to participate in the blended approach and their expectations from it. Many students (31,03%) found their involvement in virtual classroom useful and they were eager (25,86%) to give a try in new web-based learning environments. Another factor that promoted their participation was their expectation to be supported in their studies (24,14%), during the semester (Figure 7a). Most of the students (38,71%) expected to achieve a revision/review of the subject being taught and many students (29,03%) expected to be helped to answer their queries especially in difficult topics (Figure 7b).

All the students preferred to clarify their misunderstandings with an attractive way like *e-playing* or with *e-exchanging* ideas with their colleagues, rather than using the traditional boring way of self studying books. Moreover, students suggested implementation of virtual class to other courses, as well. Their answers indicated that the most of them (90,92%) would gladly participate again. Also, the majority (96,77%) preferred the combination of different e-tools, synchronous and asynchronous, since they were really helped as their success in the final examination confirmed.



(a) (b)

Figure 7: a) Factors affecting students' participation in virtual class b) students' expectations

5. Discussion

In this subsection, we present some new results on the students' perceptions regarding the effective use of blended learning techniques complementary to f2f teaching Algorithms in conventional higher education.

The majority of the students found more difficulties in understanding the pseudo-code. Therefore, when the traditional teaching of the pseudo-code is complemented with BL methods, seems to be preferable. Furthermore, students who study in parallel with f2f lectures and not only at the end of semester seem to use the forum and be supported. Sadly, the "clock-watcher's" students didn't even use the available e-tools. Surprisingly, although special care was given in order to inform all students about the available e-activities, there were many of them who were unaware. To continue with, the abstention from virtual classroom due to lack of time, is justified due to the synchronous character of this e-tool and the lack of internet connection due to undergraduates that have just "arrived" in the University.

BL supports students in understanding the taught concepts and promotes their studying during the semester. However, we were surprised to see that the lack of available time was an important factor, for first year students to prevent them from being engaged in new e-learning methods as educational games or virtual classroom. Furthermore, they did not even try to attend webcasts, post in forum although they could do it any time of the day and it was possible to arrange it whenever they had available time. They preferred to devote their time for study, in the classical way of self-study instead of trying a new way of teaching. Perhaps the majority of the students have not been persuaded yet of the benefits from participating in this type of educational activities.
In contrast, according to participated students' responses, adaptation of BL strategies and use of digital media are helpful. It is significant that many students were eager to be involved in web-based educational environments. Also, they acknowledged that there is more importance in playing educational games rather than in winning and a win comes through their knowledge on recursive algorithms. On the other hand the "losers" discovered their gaps in this algorithmic topic and they focused their study on recursive algorithms during the examination period.

The blended course is a novel experience for university freshmen which pieces together with knowledge and entertainment.

6. Conclusions

The scientific contribution of our empirical study is the presentation of some new results on the factors affecting the students' participation in the use of multiple web-based tools.

The students' expectations and positive attitude in using synchronous and asynchronous state-of-the-art e-tools complementary to f2f traditional teaching seems very promising for the improvement of academic studies in the future.

Students' perceptions regarding learning difficulties in fundamental algorithmic concepts can be used as a guide for improving teaching and learning of algorithms in Higher Education. A future work is to try to identify the students' perceptions on other type e-tools, such as web based algorithm animation software (Lazaridis et. al. 2007). It is interesting to study the students' expectations from this kind of rapidly growing web based tools.

Since instructors try to improve the quality of academic studies in Universities, our findings constitute only a first step towards to this direction and it is for sure that the BL courses should be expanded and support Higher Education. A possible future research direction is to find ways to improve the first year students' participation in BL courses.

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