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Use of Discussion Boards as a Student-Centered Methodology for Large Groups in Higher Education*

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A major problem encountered in higher education today is the high university dropout or failure rate of students coming from secondary education. Most of them drop out in the first year of their studies, primarily because at this initial stage they are affected by the high impact of university teaching after the experience of the high school educational system. This work analyzes the causes of this impact on one of the subjects that has high failure rates in Computer Engineering studies. The idea presented moves beyond the simple implementation of a discussion board to the development of a methodology for including discussion boards in a course. The method uses discussion boards as a complementary tool for learning and evaluation. It is especially useful for large groups. The methodology was put into practice during the 2007/2008 and 2008/2009 academic years, obtaining good results without loss of quality of the contents addressed in the subject.

Keywords: failures in higher education; student-centered methodology; collaborative learning; problem-based learning; group work; large group teaching; discussion boards

1. Introduction

The term 'discussion board' is synonymous with 'forum', 'virtual debate' or 'bulletin board'. The use of discussion boards in education is an area of research that has been reported in many studies in literature. This paper will focus on the gap between secondary school and higher education, and a new methodology to be used in the first-year university courses will be proposed.

Discussion boards allow asynchronous communication. They have the following features that can be advantageous in university teaching [1].

- They prompt students to review posted information and to analyze their own ideas before responding, because they are not constrained to answer immediately.
- Because most online communication is text-based, it has the potential to strengthen writing skills and encourage more deliberate articulation of ideas.
- Discussion boards are one of the most used and widespread of Internet communication tools. They are easy to use, and both students and teachers are familiar with them, so no extra learning is needed in order to use them.

Typically, when a discussion board is introduced into a university course, an active discussion is unlikely to emerge, rather, messages tend to be reflective monologues rather than dialogical interactions [1]. In the Pena-Shaff study, the majority of the messages analyzed (59%) in the discussion board could be categorized as 'clarification', 'elaboration' or 'interpretation'. Messages seem to move from a social, interactive sphere to a more individual, self-reflective sphere [1]. As an example of this idea, an opinion from one of the students who participated in the study can be used in order to characterize the use of a bulletin board: 'Conversations online are more similar to people standing up and taking the floor, one by one, and speaking as long as they want . . . It's like conversing in soliloquies . . . Our thoughts are less influenced by the other at the time of writing.'

The study of Webb *et al.* [2] analyzed the use of bulletin boards to support online dialogue in undergraduate university courses. A positive correlation between participation in e-learning dialogue and learning outcomes was demonstrated. It was also noted that passive participants, i.e. students who were merely observing the discussions ('lurking'), may also benefit from the introduction of a discussion board into a university course. According to [3], the student was compelled to become an active participant in the learning process, which enabled students to appreciate the value of participation, trust, mutual respect, and diversity. The most important result from using a bulletin board is that it leads to more reflection and discussion on the courses learning material among the students. It will also lead to a stronger student interaction, as it complements the regular class meetings.

There are also disadvantages in using a discussion board. 'Asynchronicity inherent to the medium can muddle the communication process and confuse

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participants' [4]. Also, the lack of direct response can reduce the students' motivation to participate actively [5, 6]. Pellgrum [7] focused his research on the perceptions of educational practitioners and he studied obstacles that seriously impede the realization of ICT-related goals of schools. The results, obtained from a worldwide survey among national representative samples of schools from 26 countries, showed that the major obstacles were a lack of computers and a lack of knowledge among students. On the other hand, the amount of time spent on network links is limited and the degree of emotional intensity is low as are the signs of intimacy, as stated in Jones *et al.* after studying the networking learning relationships [8]. Some studies show how an exclusively online learning method could decrease some skill levels. In [9] it is stated that the learning outcomes, which included analysis and synthesis skills, were better supported through classroom based instruction than through online instruction.

There are other techniques under study in learning collaborative environments, such as 'anchored discussion forums' as presented in [10]. Anchored discussion starts from the notion of collaborative discussion that is contextualized or 'anchored' within a specific content. The impact of this kind of computer mediated communication was measured on a group of undergraduate students involved in the collaborative processing of academic texts. Results show that discussion in the system for anchored discussion is directed more at processing the meaning of texts than on discussion in the traditional forum. However, the effects of anchored discussion on concrete learning results are still hypothetical, and it would be useful to broaden and elaborate the techniques of analysis in order to assess more closely the learning potential of certain patterns of interaction.

With regard to the aspects of feedback, a finding presented in [11] established a significant positive relationship between content and style with the revision of texts: the more feedback on content or on style, the more this feedback leads to revisions in the text. In this study a small number of feedback comments on the structure of students' texts was found. Their explanation is that feedback on structure is difficult for students to formulate properly, and it is also difficult to apply in reviewing a text. It is also suggested that the task of providing feedback on the structure of a text may be better suited to the teacher.

Small-group collaborative learning in which students have the capability of making critical discussion is a key element of effective teaching and learning in Higher Education, as was stated by Pilkington and Walker [12]. Providing this sort of education through Networked Learning (NL) is challenging. Research in Computer Mediated Communication (CMC) is revealing that facilitating effective use of these tools depends on encouraging students to take many different dialogue roles. In [12], it was shown that asking postgraduate students to reflect on the kinds of role they should take in synchronous online discussion would encourage adoption of such roles. A 'role-play' activity was introduced to postgraduate students who used a Virtual Learning Environment (VLE) as part of their course. Initial results showed that both remote and face-to-face students, native speakers (NS) and non-native speakers (NNS), working collaboratively on the same course through the VLE, had comparable outcomes on essay assignments and that NNS and distance learners slightly outperformed face-to-face students in their group work. Moreover, there was evidence that the technique of raising student awareness of roles was effective in helping (at least some) students manage synchronous online discussion more effectively, improving the overall coherence, focus, and depth of discussion.

Other studies have analyzed the use of regular forums with regard to a specific university field. For example, discussion boards have been successfully used for learning to teach Mathematics [13]. The influence of participation in virtual learning environments is analyzed by Torregrosa [14] and Valls [15]. Cos *et al.* [16] analyzed the interactions of a group of student teachers in the course of problem solving activities: their level of participation and the nature of the interaction, both in form and content. Timmers *et al.* [17] focus on an evaluation of the impact of an innovative instructional design of internship in view of a new integrated pharmaceutical curriculum. A key innovative element was the implementation of a computer-supported collaborative learning environment. The results of the study demonstrate that both independent variables (role assignment and cases) have a significant impact on levels of knowledge construction and, in particular, on the attainment of objectives of the new integrated Pharmacy curriculum.

Previous studies show that the use of discussion forums can improve student performance in university courses. However, there are other collaborative tools, although their use is not as widespread as forums. In this study we have chosen forums because these tools are easy for educators and students to use and because learning how to use a forum does not cause an extra obstacle for the student.

First-year courses usually have a large number of students (around 200–300), and it is difficult to implement teacher-based strategies for improving learning In [18] a collaborative more student-centered method has been presented for large groups.

This new methodology seems to have improved student engagement and helped to develop generic skills.

The research presented in this paper aims to implement another more student-centered methodology based on the use of discussion boards. We explore the design, development and implementation of the methodology, and assess if the student performance is improved in terms of grade average and attendance. The experiment was carried out in a first-year undergraduate course in Computer Engineering studies at the University of Alicante, Spain

The novelty of this research lies not only in using the forums as a complementary tool to classroom-based teaching, but also in the use of a carefully structured discussion board integrated in the course that is used for both the evaluation and learning of the subject. This new methodology had especially positive results for large groups.

This paper is structured as follows: Section 2 describes the academic context of this research. Section 3 presents the discussion board implementation in the Computer Engineering course. Section 4 analyzes the results obtained once the new method is applied and, finally, Section 5 shows the conclusions of the research work.

2. The basic computer course

Basic Computer Studies (BCS) is a core subject in the computer studies syllabus and it is taught in the first year of Computer Engineering studies. The corresponding 120 teaching hours are scheduled in two weekly hours of theory and two weekly hours of laboratory sessions over the 30 weeks of the academic year. The BCS course begins by describing the fundamentals of computer architecture and technology. Thus the subject is addressed to create attitudes towards the discipline and to provide an architectural point of view on computer studies, which will be fundamental for all the following, more advanced technological subjects.

From an analysis of the Secondary Education curricula, it is clear that the content of this course is far from the students' secondary studies and, therefore, the students' familiarity with BCS is less than for other basic subjects, such as Algebra, Calculus and Physics. This tends to make the student wary of the subject, which leads to a high absentee rate in sitting course examinations.

Since it is a core subject, a failure in this subject will considerably curtail any student's computer studies plans, since BCS is the prerequisite for many other subjects.

Theory sessions are held in the context of a master class or lecture for approximately 100 students, in compliance with the University of Alicante guidelines for first-year studies. These sessions take place in classrooms equipped with audiovisual facilities. The teachers' explanations are complemented by details shown on the blackboard and by slide shows (PowerPoint® for example) and by showing results using various simulation tools.

Laboratory sessions are held in groups of 20/25 students in laboratories equipped with simulation software. The reduced number of students in this case means that it is possible to evaluate them on the basis of continuous assessment, which results in a high pass rate with regard to the practical contents.

2.1 Preliminary statistics for the course

Data were compiled on the June and September examination periods from the 04/05 to the 06/07 academic year. The total number of students remained relatively stable during those three years and it was set at 200 students per year.

From an analysis of the statistical data on the number of students who sat the examinations and the number of students who passed, the following conclusions were reached.

- The low proportion of students taking the examination: In the June examinations the number of students sitting the examination never exceeded 30% of the total number of students. This percentage is lower in the September examinations, where the rates never exceeded 20%. Normally, a low proportion of students sitting an examination shows a lack of motivation on most students with regard to the subject, because they would rather not take the exam than 'more likely than not' fail it.
- In the June examinations the average pass rate was less than 40% whereas in September this average rate was 20%. A low pass rate for students who decide to sit the examination usually denotes a gap between the level of knowledge acquired and the minimal level required to pass the examination.

In order to ascertain the curricular and methodological level of the subject, the same subject programs at other universities were compared (where the conventional, traditional methodology was used). Because it is a core subject, the comparison was easy. Both the curriculum and the methodologies used in the subject do not differ from those used by other Spanish universities. Thus it may be deduced that the problem was not related to the extension or the quality of the content.

In order to define the problems underlying this subject, official opinion surveys were analyzed. These surveys are part of the Quality Improvement Program of the University of Alicante and they are

given annually to all students to fill in anonymously. The survey forms are closed and the students are questioned about the subjects enrolled (on the possible discrepancies and anomalies perceived) or about the teaching staff attitudes and/or competences.

These surveys showed that more than 70% of students perceived the main problem of the subject to be related to the short amount of time dedicated to solving problems in the classroom. This result, in particular, should be taken into account, since the examinations are based on problem solving. The current system implies a large amount of theory content, which leaves little time to spend on problem solving. Therefore only some very typical problems are solved in classroom. This deficiency can be remedied by encouraging students to solve problems at home. Not surprisingly, the survey revealed that the students' motivation for doing work at home is extremely low.

3. Discussion board-based methodology

Having identified the problems for this subject, the reasons which led to the discrepancy were subsequently explored. The analysis took place at two levels: on the one hand, at a curricular and methodological level and, on the other hand, at the level of the students' perceptions.

The following alternatives were analyzed in an endeavor to improve the pass rate.

1. Continuous evaluation of the theory contents of the syllabus. This type of evaluation has already been successfully applied in the laboratory sessions for the subject. Nevertheless, due to the considerable number of students per group (approximately 100), this proposal is not really viable for the theory content of the course.
2. Relaxation of the evaluation. Various alternatives were analyzed in order to improve the students' outcomes, such as: giving more weight to the practical work, awarding a lower weight for theory work; make the examinations easier . . . All these 'artificial' alternatives point to a potential impoverishment of basic theory knowledge, which is essential for many subjects in later stages of the degree course, since these depend on the knowledge acquired in BCS.
3. Methodology for a CMC-like proposal. In order to improve the quality of theory problems of the subject during the 2007/2008 academic year and to help provide a solution to them, the following initiative was set up.

In traditional debates in theory and laboratory sessions, the students are shown topics for discussion. The teacher chairs the debate to ensure that it is focused on common conclusions that will clarify concepts. Students write a report summarizing the opinions they have found most interesting, the overall conclusion reached, and they give their own particular opinion.

In contrast to this type of debate, a discussion board is proposed using a web facility such as that provided by the University of Alicante Campus Virtual® web tool (showed in Fig. 1). Using this system, the teacher is able to generate and motivate the debate. Having prepared the topic, students are advised of the start and finish dates of the debate (this debate usually extends over several weeks).

The teacher may also read and delete contributions in his/her role as the chairperson guiding the debate. The teacher may also halt the debate so that, without deleting existing messages, students may consult the information that these messages contain.

In order to motivate and encourage students to do exercises at home, which in turn will serve as a basis for discussion among the students, a virtual debate is proposed for each of the topics taught in BCS.

Each student is required to make at least one contribution to the debate. In this 'compulsory' contribution students must present the description and solution to a problem related to the topic under debate. This description should be original and in no way trivial. If the problem given by the student is found extremely similar to any other problem already published in a book, an examination, a web site or similar, the student will not be awarded any points. It is important to emphasize that the teacher does not correct the problems that students submit to the debate, but simply supervises their presentation and description.

Points will also be awarded to any students who detect an error in the solution to a problem presented by a fellow student. In this way, student interaction is encouraged in the virtual debating forum.

It is worth mentioning that students do not have any data on the degree of accuracy of the solution associated with the description of each exercise, and therefore this solution should be contrasted with the knowledge acquired in class and with similar exercises, which may be found in the recommended bibliography. That is, given a problem description, each student should elaborate his or her own solution and contrast it with the solution provided by the author. This increases further participation in the process of self learning. Of course, teachers can help students to perform this task.

In order to ensure that students are sufficiently interested, not only in the solution to their own

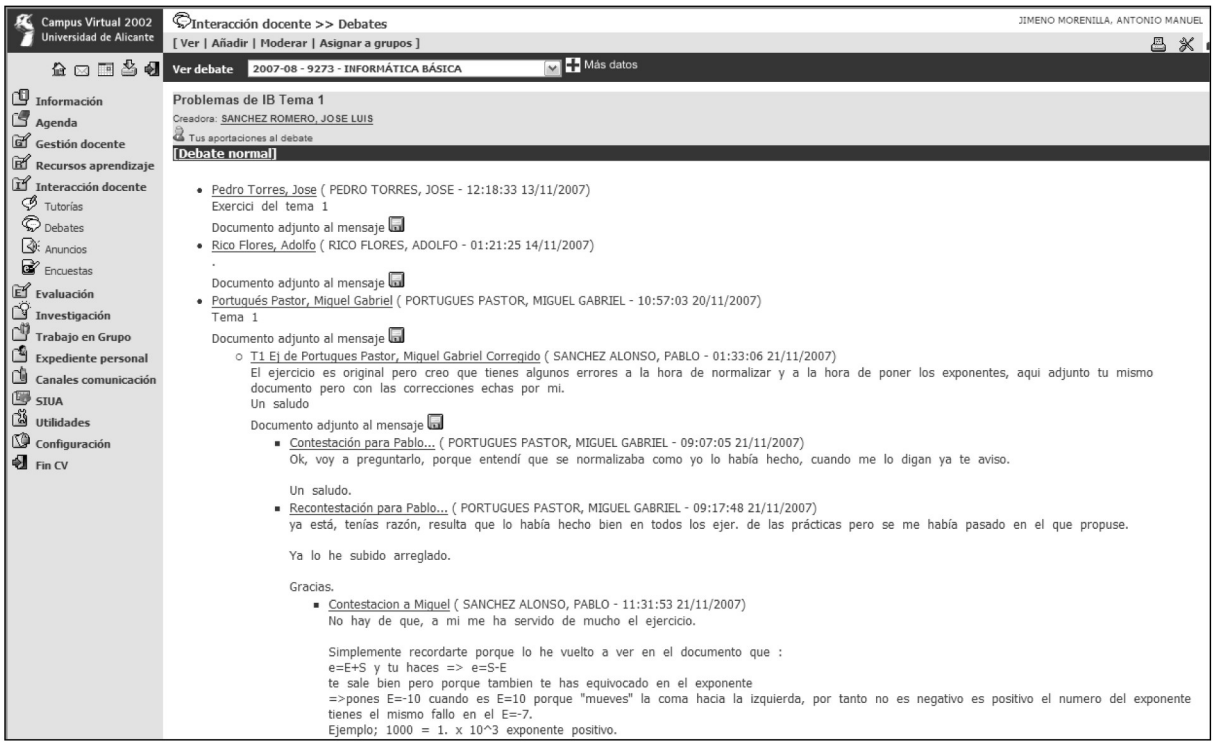

Fig. 1. Screen capture of the web based tool Campus Virtual® showing an unfolded debate.

exercise but also in those of their fellow students, the BCS guidelines establish that the theory examination will exclusively contain problems proposed by students through the discussion board.

To summarize, the marks awarded in the theory evaluation of this subject would be as follows (out of a total of 10 points): 2 points for the correct presentation of exercises in virtual debates plus 8 points resulting from a conventional theory examination. It is clear that this methodology would not be viable with just a few students, as the reduced number of exercises presented in the debates would detract from the usefulness of the theory examination exclusively based on these exercises.

4. Experiments

In order to obtain statistically significant relationships, we have carried out experiments on a post-treatment group, comparing them with another group post-test. This type of design must ensure the random assignment process. In our case, this has been achieved because it includes all students who enroll for the first time in Computer Engineering, and the university requires students to enroll in all subjects when they first start their studies. Moreover, BCS is a core subject and teachers prefer not to discriminate students of the same course. For this reason, this kind of design was selected, since there is no control group.

4.1 Participants

The sample included 987 first-year students of the Basic Computer Studies of Computer Engineering at the University of Alicante (Spain). The students were distributed among classroom groups of approximately 100 students. The average age of the students in the sample was 22 years-old (ranging between 18 and 43) of which 879 were men and 108 were women.

4.2 Instruments

We have used the official examinations of the subject. The qualifications that each student achieved are in the range 0 to 10. A mark equal to or greater than 5 allows the student to complete the subject.

Since students enrolled in a course are not required to attend the official exams, we have also collected data on the percentage attendance at the tests with respect to the total number of students registered in the subject. In a certain way, this percentage represents the self-confidence that the student has in passing the subject since the number of tries at a subject is limited (a maximum of 6) and students with low expectations of passing do not attend in order not to exhaust them.

In addition, information about the student's level of participation in the bulletin board was obtained through the number of optional exercises they submitted.

4.3 Procedure

The study was divided between two biennial periods (i.e. the next four regular academic years: 2005/2006, 2006/2007, 2007/2008 and 2008/2009) to assess the impact that the new methodology had on the student who has to re-take the course after failing the exam.

As mentioned above, in this experiment there is no control group. In order to control the environmental conditions, descriptive statistics of high school qualifications were obtained for each group. The group that applied the new methodology (2006–2008) had a mean of slightly less than traditionally taught students, and both groups had a similar standard deviation. Therefore, this pessimistic scenario favors null hypothesis testing.

The data regarding the evaluation have been compiled in the different calls that are offered in the Spanish university system: June, September and December, from course 05/06 to course 08/09.

To carry out the evaluation (i.e. examination of the subject) the exercises presented/displayed by the students in the forum were used.

4.4 Data collection and analysis

This study used a design-type quasi-experimental method called a retrospective cohort. The study compared the scores from both groups: students who received traditional instruction and students who participated in the new methodology. The variables that were considered were the attendance at the exam in the subject and the results of this exam. In order to establish the relations between the variables, for the mark of the examination, *t*-test for independent samples has been used. For the attendance, the test of independence of Chi-square was used. The statistic analyses were realized through the software tool SPSS/PC®, version 15.0.

4.5 Results

Having applied the regulations of the new methodology for evaluating the subject in the first academic year (2008/2009) some serious doubts were raised as to its usefulness. These doubts specifically included the following.

- Would the students' presentations be really original?
- Would the level of exercises presented be as high as that of examinations in previous academic years?
- Would students examine the exercises of their fellow students?

Following closure of the first debate (having concluded the first topic in the subject) many of these doubts were dispelled.

- A random sample of student exercises were distributed among ten teachers of the subject, mixed with regular examination exercises from the University of Alicante and other Spanish universities. Teachers could not distinguish between the regular exercises and the students' ones. This fact seems to indicate that the quality and originality of the students' exercises were acceptable. In the teachers' opinions, some of them were much more difficult than the average problems presented in examinations in previous years.
- Students not only participated in a 'compulsory' way; they also contributed in a voluntarily, asking questions, making suggestions and correcting their fellow students (for example, an ambiguous description could give rise to difficulties in solving the problem, which could be more serious when the problem is selected to appear in the exam).

When the debates were closed, 100 exercises per topic had been compiled and approximately 400 exercises for the whole subject and, therefore, the theory examination was fully validated. At the same time the teacher was 'liberated' from the task of proposing an exercise and solving it for the students (although it is necessary to revise problems to check they are correct, should the student have made a mistake in solving it).

4.6 Academic achievement

In this experiment we are interested in showing whether there are significant differences in academic performance between students who attended the course using the new methodology and those who did not use it.

Table 1 shows the average marks of the 460 students who attended the official examinations for the full period under study (2005–2009) classified by the type of methodology used. There is a difference of nearly 0.5 points between students who used the new methodology and those who attended the traditional. The standard errors of both samples are low: 0.14 and 0.12 respectively.

In order to check the significance of the difference between the two sample means, an independent-samples *t*-test was performed. First of all, a Levene test was carried out to determine if the population variances were equal. The significance value of the Levene test was 0.14. Because this value is above 0.10, it can be assumed that the groups have equal variances.

The *t* statistic for each sample is calculated as the ratio of the difference between sample means divided by the standard error of the difference. The probability from the *t* distribution with 458 degrees of freedom was 0.012, which is the probability of obtaining an absolute value greater than or equal to

Table 1. Descriptive statistics

Methodology	Students, *N*	Mean mark	Typical deviation	Typical error
Traditional	214	3.60	2.09	0.14
New	246	4.07	1.89	0.12

Table 2. Qualification statistics of students

			Methodology	
			Traditional	New
Qualification	Failed	Count	136	134
		%	25.8%	29.1%
	Passed	Count	78	112
		%	14.8%	24.3%
	Missing	Count	313	214
		%	59.4%	46.5%

the observed *t* statistic, i.e., if the difference between the sample means is purely random. Since the significance value of the test was less than 0.05, it can be safely concluded that the mean difference average of –0.47 is not due to chance alone, that is, it is statistically significant.

Although the difference in marks seems not to be too high, it is enough for many students have been able to successfully complete the studies (recall that, in the Spanish university system, it is necessary to have a 5 to pass the course).

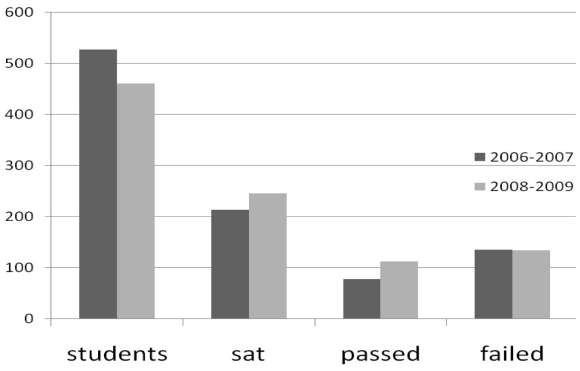

Fig. 2. Statistics of Basic Computer Studies for the traditional learning (2006-2007) and for the new methodology based on discussion forums (2008–2009).

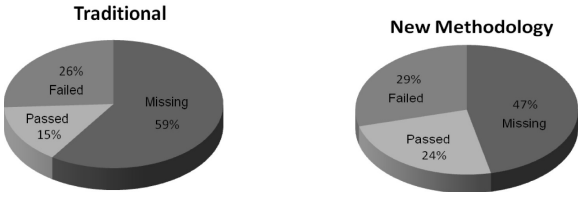

Fig. 3. Characterization of the population under study for both periods evaluated: (left) the period of traditional teaching; (right) the one with the new teaching methodology.

4.7 Academic motivation

BCS has traditionally had a high rate of absences in official exams, which denotes a lack of student interest in the subject or an implicit fear of failure.

The following experiment was conducted to test that the methodology was in the interest of the student in the course, through the number of absences from examinations, the number of passes and the number of failures. Table 2 shows these statistics for the students under study. These results, in absolute value and in percentage, are displayed respectively in Figs 3 and 4.

Figure 2 shows the absolute results. It can be observed that the number of students opting to take the official student examinations was higher (+32) in the period in which the new methodology was used, despite being less than in the previous period (–67). There was also a positive difference in the number of students who passed the exams (+34). Finally, the number of students who failed was slightly lower in the period where the new methodology was applied (–2).

Figure 3 shows the results as percentages in order to compare the two populations under study. In the examinations during the new methodology period, the number of students who passed slightly increases when virtual discussions are included in the course, from 15% to 24%. However, the most significant result is the attendance at official exams in the subject. This is the first time that the number of students who attended exceed the number of students who do not attend the exam (53% vs. 47%). There is also a slight increase in the number of students who failed the examination, from 26% to 29%, but not in the same proportion as the number who passed.

In order to verify statistically the previous results for the relationship between the methodology and

Table 3. Difference in methodology proportions

		New–Traditional
Qualification	Failed	+3.3%
	Passed	+9.5%*
	Missing	−12.9%*

* significant at 0.05 level.

the type of qualification and attendance to the examinations, we performed the Chi-square test of independence (a non-parametric test). The results showed a Pearson's Chi-square test of 20.2 with 2 d.f. that is significant at the 0.05 level.

Table 3 summarizes the statistically significant results of this test. On the one hand, the traditional methodology produces a greater number of absences to the exam. On the other hand, the new method presents a greater number of passes. Although this new methodology gives a higher percentage of students failing, the test determines that this difference is not significant and could therefore be due solely to chance.

5. Conclusions

The Basic Computer Studies subject presents considerable difficulties for students coming from the High School education system. This difficulty arises from: (a) the novelty in content; (b) it is a subject taken by an extremely large number of students, which makes personalized methods impossible; and (c) the subject contents cannot be simplified, since they are fundamental for the comprehension of a relevant number of other subjects in the computer studies curriculum.

This study reveals that one of the main causes of student failure is the difficulty of ensuring that students spend time at home studying the subject. This applies mainly in the area of theory problem solving.

The new methodology integrates a discussion board with the course at the learning and evaluation levels. The implementation over two academic years has proved positive in counteracting the negative trend in achievement in the subject in previous courses, while at the same time helping teachers in the task of evaluation and examination.

The new approach specifically encourages students to do exercises and correct them at home, which makes the method compatible with the strategies proposed by the European Higher Education System. Using this new methodology, students have the direct incentive of improving their mark in theory, the examination quality level is maintained and even improved, and the rates for students sitting and passing the examination are considerably increased.

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