HOW TO USE ICT TO HELP STUDENTS TO GAIN IN CONFIDENCE AND EFFICIENCY IN AN ALGORITHMIC AND COMPUTER PROGRAMMING COURSE?

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Abstract

Algorithmic and computer programming in the bachelor's degree is a course that demands a large involvement of students in performing non-standard exercises. This practical aspect is incompatible with classical ex cathedra course. It is the reason why we implement a blended learning approach much more responsive to students in a bachelor class of Bio Engineering at the Gembloux Agro Bio Tech Faculty (University of Liege, Belgium). This course alternates theoretical classes, take-home lessons with the help of online pedagogical resources and video and debriefing sessions where students have the possibility to benefit from teacher' support. In doing so, the students are better prepared for the examination. They also gain in confidence and motivation. The teacher no longer simply transmits the knowledge but assists the students in their reflection process and their mastering of programming tools.

Keywords: Bachelor class, ICT, blended learning, algorithmic.

1   INTRODUCTION

One of the most difficult courses that students face at the third year of Bachelor's of Bio Engineering at the Gembloux Agro Bio Tech Faculty (university of Liege, Belgium) is the Algorithmic and computer programming course. During this course the students have to learn not only a new informatic language but also a formal way to describe the solution of problems using this particular language. They face with many difficulties to analyze the problem, structure the information and design reliable algorithms. Base on this analysis, students have to translate those algorithms into a programming environment which is FORTRAN. Of course, the programming language is only a tool; the goal of this course is to introduce students to how to analyze and solve problems algorithmically and how computers work. Nonetheless, students have to deal with new tasks as edit, debug, compile and run programs they built. The amount of new tasks associated to this course leads students to consider this course as a laborious learning, which may decrease their motivation.

If the teaching of programming may be performed in a number of ways using various methods, learning happens while exercising. The understanding of the main concepts may be introduced through theoretical courses, but it's through practical programming sessions that students may acquire the skill of design reliable algorithms and translate those into FORTRAN. Due to large number of students, until now, the "algorithmic and computer programming" course combined an "*ex cathedra*" theoretical training of 2 hours (3 sessions) and face-to-face practical sessions where exercises about algorithmic and computing were realised. During those practical sessions, the teacher resolves some exercises emphasizing the process of problem solving rather than the final product. During this time, the students try to follow the teacher's explanations, by groups of 2 students, with more or less success. This situation was therefore not ideal, leading most of the students in a passive stance during those "practical *ex-cathedra* sessions".

Taking in account all those variables, the teacher suggests, this year, to use blended learning to support students in their learning of algorithmic and computer programming. According to Garrison and Kanuka [2004], "blended learning is the thoughtful integration of classroom face-to-face learning experiences with online learning experiences". In this paper, the teacher suggests the combination of feedback face-to-face sessions with online activities attached to the resolution of some integrated exercises with an increasing difficulty.

The aim of the present study is to describe the organization of this new blended learning and present preliminary data mainly related to the student's perceptions of this new learning approach.

2   DESCRIPTION OF THE BLENDED LEARNING

The "algorithmic and computer programming" course is composed by 6 units. Each unit is planned during 15 days : the first week, the students attend a theoretical session of 2 hours. During those sessions the teacher talks about concepts and theory related to algorithms. There are also collegial resolutions of exercises. Those sessions are provided by the teacher in large amphitheatres to all students. After each course, the teacher sends a practical problem to his students. They require resolving it and submitting the homework via the e-learning platform within the week. To help them, the teacher provides students different resources on the learning platform: slides, collection of corrected exercises and videos. Those short videos (4-5 minutes) dealing with specific aspects of the course (concepts, solving problems, etc.), recorded by the teacher himself, allow students to learn at their own rate. During the second week a question-answer session is organised in small groups by the teacher. This feedback session is only available to students which have submitted their homework. During this session the teacher provides individual explanations at students depending about his difficulties related to the exercise. Students are encouraged to exchange information, to discuss about their resolution. At the end of this practical session, the solutions are posted online.

3   DATA COLLECTION AND SAMPLE CHARACTERISTICS

One class of 147 third year bioengineering students enrolled in "algorithmic and computer programming" course was invited to answer to an online questionnaire developed to assess the student's perception of the blended course. This questionnaire has been posted at the end of the course just before the certificative evaluation. It focuses on student's perceptions of the blended learning experience and satisfaction. The answers are measured mainly on a 4-point Likert scale where 1 indicates "highest degree of interest or satisfaction" and 4 indicates "lowest degree of interest or satisfaction". Among those students, 107 have fulfilled the online questionnaire, 20 were rejected because the answers were incomplete. Thus, the final sample comprises 87 complete questionnaires. Among those 69 are freshmen (i.e. students from our university attending the course for the first time). Seven students have already attended this course the previous year. We call them "repeating student". Finally, 11 students are coming from other schools or universities. They attend for the first time the course. We call them "external student".

4   RESULTS

In this paper we will analyze objective data which are the final marks awarded reflecting the learning outcomes of the students and subjective data extracted from the questionnaire related to the student's perception.

4.1   Motivation related to the blended organization

This blended learning seems to have positive impact on the student's motivation. Indeed, 81 % of freshmen think that the alternation between face-to-face and virtual sessions punctuated by required homework naturally leads them to engage themselves in the learning in comparison with a classical *ex-cathedra* course. Most of the external students share this point of view (91 %). Repeating students for their part seem to be more critical about this idea. They are 57 % to think that this blended organization produces any additional effect on motivation than the classical *ex-cathedra* one.

Despite those different points of view, they are all agreed on one think; this blended course encourage them to work more conscientiously (80 % freshmen, 71 % repeating students, 91 % external students) and more frequently (81 % freshmen, 86 % repeating students and 100 % external students).

In all, they are 18 % of students to think that this blended learning is not really beneficial for them. Among those students, less than one in four are willing to give up this course in its blended form. Even if they are not really convinced by this blended course, they don't want any more the *ex-cathedra* classical course.

Concerning the structure of this blended course, the relevance of the "Q&A" sessions is frequently identified by the students as one of the highlight. They appreciate in particular the individual comments

of the teacher but deplore the long periods of inactivity. Indeed, 46.5 % of students claim that they don't have the time to ask all their questions to the teacher because of wastes of time during the "Q&A" sessions. Indeed, the teacher answers individually to students. He deals with specific problem areas of each student and makes the necessary comments and corrections. Students benefit from individualized support but they have to wait their turn! This explains why 29 % of repeating students and 3 % of freshmen suggest amending the current version of those Q&A sessions. In any case they call into question the principle of those sessions : 83 % of students consider those one as useful and efficient to assimilate the subject taught.

The requirement to send out homework appears to influence the working-time organization of students. Freshmen are 38 % to admit that without this requirement, they would not have carry out all the different exercises. Nearly 6 % of them claim that they would probably do any of those exercises. The repeating students are much more explicit: 14 % of them would achieve any exercise, 57 % only a part of the homework. The students are aware that without this obligation the regularity of homework would be significantly lower. Nevertheless, if students admit that this blended course is more efficient than a classical one to adequately prepare them for the test, they consider than the workload attached to this course is unreasonable (71 % freshmen, 100 % repeating students, 73 % external students). In the same time they are 78 % of freshmen and 86 % of repeating students to consider that this workload is required to succeed the exam.

4.2   E-Learning platform and online pedagogical resources

Students emphasize the efficiency of videos which are realized by the teacher himself. Some of them are related to specific concepts; others describe step by step the solving of typical exercises emphasizing usual difficulties. The students especially appreciate the opportunity to watch several times the video sequences. For 97 % of freshmen and 86 % of repeating students, the video recordings help them to learn at their own pace. Students indicate (96 % freshmen, 86 % repeating students) that the content of the videos is in perfect agreement with the target (i.e. problem solving approach, explanation of a specific concept, etc.). Nearly 95 % of students which have made all their homework have used those videos as support learning and validate their contents.

4.3   Effectiveness of the blended learning

Some 81 % of freshmen believe that this blended learning better prepares them to the final examination in comparison with a classical ex cathedra course. Strangely, they are only 28 % to feel ready for the exam. Nonetheless, 78 % of those freshmen successfully pass their exam. The repeating students are much more confident: They are 57 % to consider to be better prepared for the final examination after this blended learning, 43 % to be confident for the exam and finally 86 % to pass successfully their exam. External students are as pessimistic as freshmen: only 27 % think to succeed their examination. They are 81 % to consider that this preparation is better than the classical one but at the end there are only 54.5 % to pass successfully their exam.

This year, 67 % of the students passed their exam in comparison with only 25 % last year. Some 80 % of students which have done their homework and assisted to Q&A sessions succeed the exam in comparison with only 68 % for students which did not assist to the Q&A sessions. It seems that those face-to-face sessions are really important into the acquisition of knowledge. It should be mentioned that 75 % of students which have not submitted the homework nor assisted to the Q&A sessions, passing the examination. Obviously, in this range of students we found, in addition of dropping out students, autonomous ones which are able to organized themselves their learning.

It should be underlined that 75 % of students which have fulfilled the survey pass their exam in comparison with the 67 % of global success rate related to this course this year. This can introduce a small bias into the results.

4.4   Prediction of the student's mark according the answers to the survey

In order to appreciate the relevancy of asked questions, in regard with the performance (i.e. score obtained after the summative evaluation), a stepwise regression was performed from the 29 asked questions using PROC GLM (SAS software, 2014). Based on the obtained results, 5 questions were highlighted. By decreasing importance, there were Q14, Q16, Q19, Q13 and Q21 (Table 1). All of these questions have a significant p-value (i.e., p-value lower than 5 %).

N°	Answers to the different questions	Estimated value	p-value
	Intercept	17.58	<0.0001
Q14	You think that you're completely unprepared to the exam	3.55	0.0341
Q14	You think that you're not optimally prepared to the exam	-2.11	0.1220
Q14	You think that you're prepared to the exam	0.37	0.7403
Q14	You think that you're prepared optimally to the exam	0.00	-
Q16	The face-to-face sessions of this blended learning have to be improved	-3.06	0.0004
Q16	The online sessions of this blended learning have to be improved	-0.87	0.3566
Q16	The organization of this blended learning is really weak	-1.23	0.4428
Q16	The organization of this blended learning is perfect	0.00	-
Q19	The duration of the video is perfect	-3.59	0.0015
Q19	The duration of the video is too long	-3.05	0.0484
Q19	The duration of the video is too short	-6.16	0.0003
Q19	There are too many videos and their duration is too long	0.00	-
Q13	The organization of this blended course has any effect on your involvement in the learning	-3.62	0.0771
Q13	The organization of this blended course doesn't lead you to engage yourself in the learning	1.68	0.1666
Q13	The organization of this blended course leads you to engage yourself a little more in the learning	-0.69	0.4241
Q13	The organization of this blended course leads naturally you to engage yourself in the learning	0.00	-
Q21	Next year you'll prefer a 100% face-to-face course (classical ex-cathedra course)	-0.53	0.6434
Q21	Next year you'll prefer a 100% online course	-1.57	0.0945
Q21	Next year you'll prefer to keep the current blended version	-0.34	0.6787
Q21	Next year you'll prefer to keep the current blended version with an amendment of the Q&A sessions	0.00	-

Table 1 : Estimates obtained by the stepwise regression

The coefficient of determination obtained for this regression was 0.44 (Fig. 1). This means that those 5 questions explained 44 % of the observed variability related to the score obtained after the summative evaluation (Fig. 1).
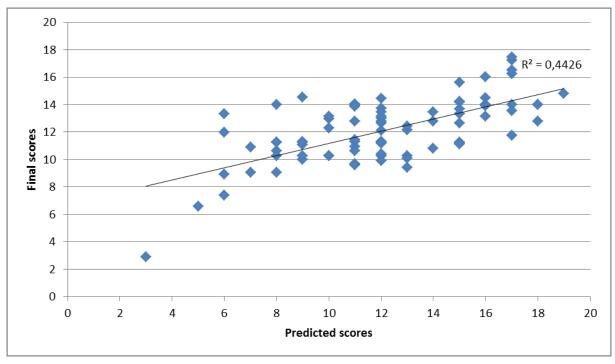
Figure 1 : Relationship between the scores obtained after the certificative evaluation and the predicted scores based on the response given to the 5 highlighted questions.

According to the results (Table 1), it seems that a student which is suspected to obtain the best score is a student which appreciates the blended learning as organized this year. This student is self-confident but not too much. He does not need to watch the videos to solve its exercises and is already motivated to learn. Therefore he does not feel an increase of motivation due to the blended structure. In fact this student is already autonomous. The blended learning gives him flexibility in its organization but in fact this student is not really an at-risk student.

By contrast a student which seems to be too dependent will obtain a lower score. This student finds the videos too short because he needs a lot of explanations, examples to understand what he is being asked to do. He likes to improve the face-to-face Q&A sessions surely because he needs to ask a lot of questions to his teacher. This student is not self-confident and thinks that this blended learning has no effect on his motivation.

5   DISCUSSION AND CONCLUSION

The analyzing of the blended learning of the "algorithmic and computer programming" seems to indicate that there is a significant effect on achievements levels and knowledge retention. Of course, this trend has to be confirmed during the next years.

The satisfaction of students about this blended learning leads them to have a positive attitude towards the learning. It appears that the combination of face-to-face Q&A sessions and online activities reinforces student's understanding of the subject, supporting their learning process, leading them to have a positive attitude towards the learning.

This organization changes the teacher's role. He monitors student's learning and provides them feedback and individual remediation. The relationship between the teacher and his students moves towards a partnership. For students it's important to talk with their teacher to have feedback and explanations about their problems [Chandra & Fisher, 2009].

Students struggle with time management and responsibility for their own learning. It seems that blended learning helps them to plan their own learning [Smyth et al., 2012]. As in the study of Hugues [2007], it appears that the mixture of well-prepared face-to-face with online sessions help to improve the personal work planning. Remember that 79 % of students confess that without the requirement to submit homework they would not do the exercises. Learners do not automatically know to achieve autonomy, they need to be guided in developing it and blended learning helps them in this way [Snodin, 2013].

Concerning the workload, the students acknowledge that it is too heavy. Nevertheless, they believe that it would be useful to maintain the blended process and the homework. They recognized that it is necessary in order to succeed in their exam.

Further analyses are currently in progress trying to identify the different profiles of students according their motivation, their autonomy and their feelings about online activities

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