

Using Competition-based Learning in a Erasmus-based ICN at the Bachelor Level: a Case Study

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Abstract— This paper describes an experience of applying Competition-based Learning (CnBL), to motivate the students and increase their learning performance. We describe the learning activities performed in a bit-sized Erasmus module, where CnBL has been used. The experience gained is described together with an analysis of the feedback obtained from the students' surveys. The survey results suggest that the use of friendly competitions provides a strong motivation for students, helping them to increase their performance.

Keywords— component; Cooperative/Collaborative learning, improving classroom teaching, teaching/learning strategies, Competition-based Learning.

I. INTRODUCTION

The use of games to promote student's learning has been done in the past to capture student's interest, since all of us learn better when we are motivated [3]. Most of the students have intimate contact with computer games before their formal computer education begins, and adequate these games can attract and motivate them to learn more and better. Computer games as educational tools also have an intrinsic motivational factor that encourages curiosity [11] and creates the impression to the students that they are in control of their own learning.

The use of games and competitions to promote the desire to improve has been explored in the recent literature in introductory data structures and programming courses (Adams, 1998; 2)??). Other assignments include game projects [9], inter-process communication [16] and operating systems [8]. Aside from the peculiar aptness of games for teaching AI, there are many pedagogical arguments to support the use of games in teaching in general, and programming in particular. In recreational computer games, players engage in processes such as proactive/anticipatory, recursive thinking, organization of information, general search heuristics, mean-ends analysis, and the generation of alternative solution paths [15]. In this approaches, Game-based Learning (GBL) engages players in learning activities, usually by means of educational video or serious games. These last ones are designed to promote active participation and interaction as the centre of the experience, instead of pure entertainment. A few approaches, denoted as Competitive-based Learning or Competitive Programming, have successfully considered competitive games to promote learning in secondary and higher education, mainly in AI courses [12, 22, 7, 19].

Game-based Learning (GBL) can be combined with similar learning methodologies as Collaborative-based Learning (CBL) [17], Problem-based Learning (PBL) [1, 13] and Project-based Learning (PjBL) [1,4]. All these learning approaches are described next.

Collaborative-based Learning (CBL) methodology focuses on activities that maximize the collaboration among students, either in couples or small groups, to improve their learning activities and results. The idea is to enhance the exchange of information and knowledge among the students to motivate their own learning and a common reinforcement.

Problem-based learning (PBL) is a student-centered instructional strategy in which students collaboratively solve problems and reflect on their experiences. In PBL, learning is driven by providing open-ended problems where students usually work in small collaborative groups and they are encouraged to take the responsibility for organizing their group, and managing the learning process with specific support from a tutor or instructor that take the role of learning facilitator.

Project-based learning (PjBL) provides complex tasks based on challenging questions or problems that involve the students' problem solving, decision making, investigative skills and reflection, that are supported also by a tutor that provides facilitation. The classroom projects are intended to bring a deep learning in issues related to their education. The difference between PBL and PjBL is that in the former (PBL) the teacher specifies the task to be performed at a basic granularity level, while in the latter (PjBL) the teacher specifies a greater task and lets the students to self-organize the subtask division. A previous experience in the field of Medicine has also highlighted the usefulness of these approaches [18,6,14].

The work presented here describes an experience using Competition-based Learning (CnBL) [5] in an Erasmus-based ICN at the bachelor level in the University Joseph Fourier in Grenoble (France). CnBL is a methodology where learning is achieved through a competition, but the learning result is independent of the student's score in such competition,; while Competitive-based Learning, or Competitive Programming, implies that learning depends on the result of the competition itself [10]. CnBL can be easily combined with other learning methodologies such as CBL, PBL or PjBL, and altogether they support tournaments among groups of students, using this to motivate them and helping to improve their performance.

The rest of the paper is organized as follows. Section II provides a basic description of International Curricula Networks. Section III presents an example of an Erasmus-based ICN at the Bachelor level. Section IV introduces a case study of a Competition-based Learning approach performed within the Erasmus-based ICN. Section V presents the results obtained from the case study. Finally, Section VI draws the conclusions.

II. INTERNATIONAL CURRICULA NETWORKS (ICN)

An ICN is a set of partners who agree all together to share common (partial or total) curricula in a speciality. Ideally, these shared curricula should be recognised at the accreditation level, but the process can be difficult in some cases. In order to initiate the ICN, we consider two pragmatic cases:

- Cross recognition of curricula (learning outcomes, competences, Tuning approach), which is the fact when at least two institutions agree on common modules for an ERASMUS exchange of students and/or teachers.
- Shared recognition of modules, which is the case when a set of modules is developed and implemented within the frame of a programme (in particular distant learning modules). Concerning this second point, we can consider the practical use of the module in various ways:
 - o Distant course without tutor.
 - o Distant course with distant tutor.
 - o Distant course with local tutor.
 - o Local course.

The last role of the ICN is to act as a “pedagogical committee” to identify good approaches in the setting of existing or new Life Long Learning (LLL) curricula.

III. AN ERASMUS-BASED ICN ON NETWORKING AT THE BACHELOR LEVEL

The following experiments have been achieved in 2009-2010, as a first attempt to define the precepts of International Curricula Networks and International Modules, within the frame of the “Final year of the Professional Bachelor’s Degree in Computer Networks and Telecommunications specialising in Wireless Networks and Security” (WiNS) [20,21]. This programme was launched in Grenoble in September 2007 as an unexpected outcome of the previous Thematic network EIE-Surveyor (www.eie-surveyor.org).

A. Experiments Concerning Erasmus Student Exchanges

In this part we describe the experiments dealing with Erasmus student exchanges.

1) First Experiment

The first experiment concerns both student and teacher international exchanges,

- Two students from University of Vigo from Technical Telecommunication Engineering, speciality in Telecommunication Systems (*Enxeñaría Técnica de Telecomunicación, Especialidade de Sistemas de Telecomunicación (ETTST)*).
- Two students from Higher Education Institution of the Province of Liège from the Bachelor in Industrial computing, option network and telecommunications (*Bachelier en informatique et systèmes finalité réseaux et telecommunications*).

All these students attended the autumn semester of the WiNS courses, with the subjects recognized by the students’ home institutions. For the spring semester, the Belgian students went back in Liège and passed some courses and a training project. Both were recognized in Grenoble so the students passed the two diplomas. The Spanish students stayed in Grenoble in order to get some extra courses, and also stayed at companies for their internship in France. These activities were recognized both by Grenoble and Vigo, which means that the students got also the two diplomas.

Therefore, this first experiment of an ICN done in Grenoble obtained concrete results.

2) Second Experiment

The second experiment concerns the case of a Slovak student, who attended the autumn semester in Grenoble, and then went to Germany (within an ERASMUS agreement between Grenoble and the German institution). So this student, registered in Kosice, spent one semester in Grenoble and the other one in Germany, and he got recognized the Slovak and the French bachelor.

3) Third Experiment

The last scenario concerns a Finnish student, who attended only the autumn semester in Grenoble, and then went back to Finland for the spring semester. In his Finnish curriculum, the student followed courses but no internship. He naturally got his Finnish diploma. Concerning the French Professional Bachelor, the internship experience was missing, from the formal point of view, but this student got a previous professional experience, working in some companies in networking and security. Thus the final jury decided to give this student the “Licence Pro”, considering his professional experience as an AEL (Accreditation of Experiential Learning).

These are some examples of an ICN, composed by several universities in Europe, around an existing curriculum, and based on ERASMUS exchanges.

B. *Experiments Concerning Erasmus stuff Exchanges*

Vigo and Liège are two partner universities of Grenoble in this experiment. Prof. Juan Carlos Burguillo, from the University of Vigo and Prof. Pierre de Fooz, from the University of Liège, visited Grenoble within the staff ERASMUS programme in order to give a “bit-size” module:

- “Internet and WiFi security”, within the frame of the module “Security of Networks” for the Spanish colleague,

- “IPV6 Protocol”, within the “Network” module for the Belgian colleague.

These “bit-size” modules were recognised by Grenoble, by the home institution of the students and also in an informal way performed by the other institutions to collaborate with Grenoble within the WiNS programme. For example, a student coming from AGH Krakow, following the WiNS course in Grenoble, validated the bit-size module of “Internet and WiFi Security” from the University of Vigo.

Various universities from the ELLEIEC project are partners of UJF Grenoble in this experiment:

- CTU Prague (partner P13)
- Technological Educational Institute of Crete (partner P32)
- University of Vigo (partner P35)
- Technical university of Kosice (partner P41)
- AGH University of Science and Technology (partner P45)
- Technical University of Valencia (partner P55)
- Haute-Ecole de la Province de Liège (partner P60)
- Cracow University of Technology.

Another interesting experiment, not more explained in this paper, concerns the setting of 6 LLL modules, developed by a set of partners within the CD project ESPANT (<http://www.advancednetworking.eu/>), in the field of networking. A cross-fertilization experiment is on the way between ELLEIEC and ESPANT.

IV. USING COMPETITION-BASED LEARNING IN A BIT-SIZE MODULE: A CASE STUDY

During one of the “bit-size” modules described in the previous section, an experiment of Competition-based Learning (CnBL) has been performed with the students.

The duration of the bit-size module was five hours and it dealt with the topics of Internet and WiFi Security. The contents of the course were the next ones:

1. Introduction to Vulnerabilities, Threats and Countermeasures.
2. Security Policies.

3. Countermeasures: Antivirus, Firewalls, Protocols, VPN and IDSs.
4. Cryptography.
5. Wireless and Cellular Networks.

During the first 3 hours, the teacher provided a theoretical introduction to the main topics of the syllabus using a classical teaching oriented style. During the last two hours, the students used a Collaborative-based Learning (CBL) approach together with a Competition-based Learning (CnBL) approach to review the contents of a set of slides concerning the topic of wireless and cellular networks.

A. *Student Profile*

A total number of nine students followed the whole course, but only 7 could assist to the last part where the CnBL experiment was carried on. These students belong to the International Professional Bachelor’s Degree in Wireless Networks and Security provided by the Université Joseph Fourier from Grenoble (France).

As this is an International Bachelor Degree, the students formed a very heterogeneous class. In the case described in this paper, the students came from: Algeria, Belgium, Brazil, Greece, Poland, Spain and Sri Lanka.

B. *Description of the Activity*

At the beginning of the last practical part, the whole group of seven students was divided randomly in two teams, one with four students and the other one with three. In every team, the students had to divide the whole amount of slides among them, as the time provided to learn the slides (10 minutes) was not enough to review the whole number of slides (46) by every student alone. Therefore, the team with four students reviewed an average of 12 slides per student, while the other team with three students around 15 slides per student.

After this phase, the students entered in a second one, where the members of the team had to join and to transmit their team mates what they have learnt. Therefore, during the following 20 minutes, the students had to explain what had they learnt during the first part of the experience. In this second phase, it was important to have a clear idea of the learnt material, and also to explain the main points shortly and clearly to the team mates.

Finally, the students had to follow a self-evaluation questionnaire of 10 questions to be performed in 5 minutes, related to the whole contents they had studied during the experience. The idea was to measure what a student had learnt by himself and what their team mates taught him about the rest of the contents. This is the Collaborative-based Learning approach considered in this paper.

All the marks obtained by the team were added and divided by the number of team members to get the average mark obtained by the team. The one with the highest average mark won the competition. This is the Competitive-based Learning approach.

At the end of the class, the students filled a survey about the CnBL experience performed.

V. RESULTS FROM THE CASE STUDY

This section describes the results obtained by the students in the questionnaires, grouped by teams, and also the results of the survey developed within the ELLEIEC project to evaluate this type of activities.

A. Team Results

The results obtained by the team of 4 members (in a 0-10 scale) were: 9, 9, 10 and 8, giving an average of 9 over 10 for the whole team.

The results obtained by the team of 3 members were: 8, 10 and 8 giving an average of 8.66 for the whole team.

Therefore, the first team was the winner of the experience, even when the results were very similar between the two groups. But the most important part is that the motivation and

the attention of the students in this last part of the seminar was very high; especially considering that it was performed during the last hours of the seminar, when the attention usually decreases. This positive feedback was also pointed out in the results of the survey filled by the students, which is shown next.

B. Survey Results

The results of the survey appear in Table I. We can see the answers provided by all the students participating in it.. The answers range from 1 (lowest valuation) to 5 (highest valuation).

In a general analysis, the students felt satisfied with the learning methodology (3.85), learned better (3.71) and they can monitor their own learning (3.85). The instruction support is below 3 (2.71) and the time needed is lower than a traditional class (2.85). One of the more interesting capabilities of this learning style is the interaction (4.28) and collaboration (4.42) with other students. Overall, the students felt satisfied with this course approach (3.85) and they would recommend the approach for other courses (4.14).

Therefore, the higher values correspond to interaction with other team members and collaboration within the team. They also would recommend the approach for other courses.

TABLE I. ANSWERS TO THE SURVEY RELATED WITH THE LEARNING METHODOLOGIES USED ALONG THE COURSE

Question/ Student ID	1	2	3	4	5	6	7	Average
I am satisfied with this methodology of learning	5	4	3	4	4	3	4	3.85
I learned better with this approach	3	3	3	4	4	4	5	3.71
The pedagogical method helps me monitoring my own learning	3	4	3	4	4	5	4	3.85
The pedagogical method engages me more in the course work	2	4	3	4	4	5	4	3.71
I needed instructor's help to following the material	2	3	3	2	2	3	4	2.71
The pedagogical method motivated me to interact more with my teacher and the other students	4	4	4	4	4	5	5	4.28
The pedagogical method enabled collaborative work with the other students	5	4	5	4	4	4	5	4.42
I put more time for learning the course material than traditional class	3	2	3	2	2	5	3	2.85
My expectations at the beginning of the course were very high	4	3	3	3	3	3	4	3.28
The course approach has met my expectations	3	4	5	4	4	4	4	4
Overall, I was satisfied with this course approach	4	4	3	4	4	4	4	3.85
I would recommend this approach for other courses	4	4	3	4	4	5	5	4.14

VI. CONCLUSIONS

This paper describes an experience using Competition-based Learning (CnBL), together with Collaborative-based Learning (CBL), to achieve a stronger motivation for the students and increase their learning performance. The main contribution of the paper is the use of the CnBL approach to motivate the students during a Erasmus seminar in a bit-sized module of an Erasmus based ICN at a bachelor level in the University Joseph Fourier of Grenoble (France)

The results and mainly the feedback gained from the students suggest that the CnBL methodology discussed here motivates students to improve their work by competing against other students grouped in teams. The qualitative opinions provided by the students and the similarity of the surveys' results indicate that the use of friendly competitions provide a strong motivation that helps to increase the student performance.

This competition approach can be used in multiple courses and disciplines but teachers should consider the main concepts of the approach discussed here: use friendly competitions among students' groups, locate the tournament at the end of the course (to avoid lack of interest in non-successful players), and adapt the competition to the discipline style and the course contents.

Among the advantages of the competitive approach we may cite: interactivity, collaborative work inside the group, active participation, challenge versus duties, and student's motivation.

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