

EFFECTS OF COMPETITION IN EDUCATION: A CASE STUDY IN AN E-LEARNING ENVIRONMENT

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ABSTRACT

We analyse the effects of competition in education. We identify the benefits and drawbacks of forcing students to compete themselves during their learning process, and investigate a number of features a competitive learning activity should have in order to motivate students, and improve their academic performance. More specifically, by using a simple Web system, we conduct a competition undertaken for a symbolic value, performed in a short period of time, and characterised by all participants feeling like they have a chance to win. Following these principles, empirical results with 77 students show that a balance between competition and cooperation is achieved, and the focus on the learning goals instead of on the competition itself remains.

KEYWORDS

Education, e-learning, student motivation, competition, cooperation.

1. INTRODUCTION

Human competition is a contest where two or more people strive for a goal that cannot be shared, usually resulting in a victor and a loser. Individuals and/or groups are then in a position where they must vie for the achievement of an outcome. For example, in most team sport competitions, teams engage for the purpose of winning matches to take first place in a tournament.

It is controversial whether competition in education is positive or not. Hence, for example, Verhoeff (Verhoeff, 1997) is a strong supporter of its benefits, claiming that a well-organised competition challenges its participants to give their best, and thus it enhances student motivation and learning. Lawrence (Lawrence, 2004) agrees on that idea saying that competition encourages active learning and increases motivation. Fulu (Fulu, 2007) also recognises several odds in competitions, such as recognition gain, and higher motivation and self-esteem. Moreover, Fasli and Michalakopoulos (Fasli & Michalakopoulos, 2005) show that a competitive element acts as an incentive for all students to put in more effort and even weaker students persist with participating in the activity. In this line, Siddiqui, Khan and Katar (Siddiqui, Khan & Katar, 2007) present a study that demonstrates there is a high sense of competition among students. Lam et al. (Lam et al., 2001), however, state that competition damages the learning process by forcing students to focus on goals instead of on the process itself. Vockell (Vockell, 2004) also argues that the stress to which a student involved in a competition is exposed has a negative effect that is greater than the benefits extracted from it.

Apart from this controversy, there is a more general agreement that team competition is less harmful for students, and can effectively improve their learning skills. Thousand et al. (Thousand, Villa & Nevin, 1994) state that cooperative goals make students take better care of their responsibilities and tasks for the sake of their groups. Yu et al. (Yu et al., 2002) examine students' preferences towards different kinds of competition and their satisfaction with regard to the learning experience. Their results show that students prefer anonymous rather than face-to-face competition, since the former is more likely to reduce stress and other similar negative emotions. Moreover, Shindler (Shindler, 2007) defines a "healthy" competition as a short activity where outcomes have to be trivial, and which has to be focused on the process rather than on the outcomes.

Aiming to clarify the above controversy, and attempting to develop a healthy competition approach in a simple e-learning environment, we present herein an empirical study in which a number of students

participated in and evaluated a competition whose main tasks were the wording, answer and evaluation of questions on a given subject. In this study, we evaluate whether or not a cooperation-based competition has the advantages associated with individual competition, and if it lacks the disadvantages of the latter. We also analyse if obtained insights are valid for all the students in the same way, or if the students' perception and effectiveness depend on their ranking position in the contest.

We hypothesise that competition in an e-learning environment inherits the advantages of both cooperative activities and healthy competitions. Consequently, we suppose that it may boost student motivation and academic performance, improve the social atmosphere among them, and avoid problems mentioned before such as the stress level increment and the quality reduction of the learning process.

The rest of the paper is organised as follows. Section 2 describes in more detail the conditions that a competitive activity should have in a learning environment to be "healthy", i.e. beneficial (not harmful) for the students. Section 3 describes the case study conducted to evaluate our proposal, and validate our hypothesis. Section 4 and 5 respectively present and discuss the results obtained from the study. Finally, Section 6 ends with some conclusions, and depicts some future research lines.

2. COMPETITION IN THE LEARNING ENVIRONMENT

Although it is under discussion if classroom competition can be healthy, what it is clear is that there are features that a competitive activity should have in order to make it more beneficial, or at least not harmful (Shindler, 2007; Thousand, Villa & Nevin, 1994; Yu et al., 2002). In this section, we briefly discuss some of these features, which are related to the definition of healthy competition given in (Shindler, 2007).

First, prizes for winners should be either symbolic or of very little importance, in order to assure the students' efforts are intrinsic and not driven by the expected outcome. When we give students a meaningful reward for winning, we make the winning what is important, and students care at least as much about getting the reward as they do about the quality of their effort. In particular, recorded grades of high relevance, material things of value, and privileges of any kind must be avoided at all cost.

Second, the competition should be short. The length of the contest increases its sense of prominence, and decreases its sense of intensity and fun, both undesirable effects. On the other hand, the competition has to be long enough to avoid student demotivation because of bad initial results, and to assure that all participants have a good chance of winning until the end of the activity.

Finally, the goal of the competition must be clearly set into the process instead of into the results, making it clear that finally winning or losing is very low in importance in comparison to learning and improving while competing. In order to achieve this, the first feature (symbolic prizes) can be considered as a prerequisite since setting a valuable prize for the contest may easily lead students to focus on it.

When taken together these three features we could conclude that the most healthy and beneficial competitions are those that are undertaken for exclusively symbolic value (e.g., "good job you won", "polite applause for the winners", etc.), short, and characterised by all participants feeling like they have a chance to win, and have the process and quality of work being given conspicuous value. In our study, we attempt to ensure that the competition is as healthy as possible, by setting the above criteria strictly in the process.

3. CASE STUDY

The conducted experiment took place in a "hostile" learning environment. It was performed in a subject called Applied Informatics, which is taught to Chemical Engineering first year students at Universidad Autónoma de Madrid, Spain. The subject contents include theoretical and historical aspects about Computer Science, as well as a practical part involving MATLAB¹ programming. In general, this particular subject is usually seen as non-relevant and/or very difficult by most of the students. Because of that, their motivation and expectations on the subject are generally very low. Moreover, the creation of the European Higher Education Area (EHEA) following Bologna Accords, and its implementation in Spanish universities, makes it necessary to organise specific activities to provide a continuous assessment procedure. In order to fulfil the

¹ MathWorks - MATLAB and Simulink for Technical Computing, <http://www.mathworks.com/>

EHEA objectives, student motivation is seen as a key feature (Regueras et al., 2008). Unfortunately, for the above subject, the current number of students in the classroom is very high, and organising such activities consumes most of the teachers' time, and does not benefit students as much as it could with smaller groups of students. Apart from the investigation of the effects of competitions in a simple e-learning environment, the presented work intends to face the mentioned two problems.

By using a Web system based on Google Docs², we organised a competition in which groups of students had to pose several multiple-choice questions relating to topics studied in the subject. Then, the teacher accessed the system to validate, evaluate and publish the received questions. After that, each group of students answered and evaluated the questions provided by the rest of the groups. Once gathered all teacher and student answers and evaluations, a score was computed for each group. This was done through several stages (competition rounds), covering different topics of the subject. The subsequent subsections describe in more detail the activity tasks and scoring procedure.

3.1 Competition Description

The competition had 77 students who were distributed in 17 groups of between 4 and 6 members each. It was the students themselves who made the registration in the competition, teaming with whoever they wanted in the classroom. Each group chose a name for the competition. The registration process was done via Web, so the members of a group remained anonymous for participants belonging to other groups.

The competition itself consisted of three two-week rounds. In each round, the student groups had to perform two tasks. In the first task, they had to prepare 4 theoretical multiple-choice questions about the last topic studied in the classroom, and submit them to the Web system via online forms. The teacher was notified when new submissions were placed on the system. Then, he corrected and evaluated the received questions. Once the teacher had validated all questions, they were sent to the student groups. In the second task, each group was requested to answer the questions prepared by the rest of the groups, and also to evaluate their quality based on several criteria established by the teacher. According to the number of questions correctly answered, and the question evaluations given by the teacher and the rest of participants, each group was assigned a score (see Section 3.2). The scores of all groups were published after each round so students knew how they were going in the competition. The final score of a group was the sum of its scores in the different rounds.

In order to keep track of the study, the students were asked to fill in online questionnaires at several points of the experiment. Before starting the competition, they completed an optional introductory questionnaire that was made individually and anonymously. Students were also asked to complete questionnaires after each round of the contest, in the same optional, anonymous and non mandatory way. These intermediate questionnaires were intended to measure the tasks difficulty, and the students' perception about the utility of the activity. Finally, there was one final compulsory questionnaire asking questions about satisfaction and fun of the students involved in the experiment. In this last questionnaire, students were asked the name of their group, in order to allow measuring statistics relating each group ranking position in the contest with its provided questionnaire responses.

The contest winners got a (symbolic) surprise gift and the congratulations from their classmates. An event was held in the classroom to give the winners their prize.

3.2 Competition Scoring

The performance of participants in the contest was evaluated as follows. Let G be the groups of students who participate in the competition. The total number of groups is $|G|$ (17 in the experiment). Let p be the teacher of the subject who evaluates the questions submitted by the different groups. We define $S = G \cup p$ as the set of subjects involved in the competition, i.e., the groups of students and the teacher.

Let Q be the set of questions a group submits at the current round of the competition, and let $|Q|$ be the number of submitted questions per group (4 in the experiment). By $q_{g,i}$ we denote the i -th question submitted by group g . Let $eval(s, q): S \times Q \rightarrow [0,10]$ be a function that corresponds to the evaluation given by subject s to question q . Let $answ(g, q): G \times Q \rightarrow \{0,1\}$ be a function that is 1 if group g answers correctly question q .

² Google Docs, <http://docs.google.com/>

and 0 otherwise. Finally, let g_a be the active group, i.e., the group whose score we want to compute at current stage of the competition. The score obtained by group g_a is a function $score(g): G \rightarrow [0,10]$ defined as:

$$score(g_a) = \theta_{eval} \frac{1}{|Q|} \sum_{i=1}^{|Q|} eval(p, q_{g_a,i}) + \\ + \theta_{diff} \left(10 - \frac{\sum_{g \neq g_a} \sum_{i=1}^{|Q|} |eval(p, q_{g_a,i}) - eval(g, q_{g_a,i})|}{|Q| \cdot (|G| - 1)} \right) + \\ + \theta_{answr} \cdot 10 \cdot \frac{\sum_{g \neq g_a} \sum_{i=1}^{|Q|} answr(g_a, q_{g,i})}{|Q| \cdot (|G| - 1)}$$

where $\theta_{eval}, \theta_{diff}, \theta_{answr} \in [0,1], \sum_i \theta_i = 1$, are fixed parameters that weight the influence of three factors considered on the computation of the score value: the teacher's evaluation of the active group's questions, θ_{eval} , the difference between such evaluation and those provided by the rest of the groups, θ_{diff} , and the percentage of correct answers given by the active group for the questions of the rest of the groups, θ_{answr} .

The values of the fixed parameters taken in the conducted experiment were $\theta_{eval} = 0.5$, $\theta_{diff} = 0.3$, and $\theta_{answr} = 0.2$. This choice of the values assures that there are not unfair evaluations among students. Since student evaluations are compared with the teacher's evaluations, the really better student questions obtain higher evaluation values. The parameter setting also assures that there is a high probability that changes may occur in the rankings of the groups until the last round of the competition. In fact, during the competition, there were significant changes in the classification table through the rounds.

4. RESULTS

In this section, we summarise and discuss the results obtained from the different questionnaires that students completed during the experiment.

4.1 Introductory Questionnaire

The introductory questionnaire was intended to measure several features in order to understand two important issues: how hostile the learning environment where the experiment took place was, and the actual background and knowledge on Computer Science students had before taking the course. There were 54 responses out of a maximum of 77 students involved in the activity.

To get that information, students were asked questions about their initial interest in the subject, the difficulty they expected the subject would have, and the use and utility they thought the covered topics would have for their academic training. The results showed that students felt Computer Science as being very important for Chemical Engineers, but expected that the subject would be difficult. 33 out of the 54 students said they would like the subject, and only one thought he or she would dislike it. Finally, and quite surprisingly, two thirds of the interviewed students said they would like the studied topics after taking the course, despite the fact that they showed a medium to low interest in computers and Informatics in general.

On the other hand, the students' previous knowledge and background were tested by asking about their experience and skills with concrete computer applications including office automation, operative systems, and programming languages. Most of the students used computers regularly, but they only knew how to use common programs, such as word processors, Web browsers, and media players. Nearly none of them had any programming experience.

4.2 Intermediate Questionnaires

After each competition round, students were requested to optionally fill a short form, asking them about the difficulty and time they spent in performing the competition tasks (i.e., writing the own group questions, and answering and evaluating the questions of the rest of the groups).

An average of 35 out of 77 students participated in these questionnaires. Table 1 shows a summary of their responses. It can be seen that, in general, the activity was not difficult for the students. There were some difficulties in evaluating the questions provided by other groups. Students told the teacher that the evaluation criteria were not clear enough in the first round. Apart from this issue, results show that students found the activity useful to review/study the subject, without spending too much time per round (on average, between 1 and 2.5 hours).

Table 1. Response statistics obtained from the intermediate questionnaires.

Question	Answers	Percentage of responses
How useful was the last competition round for you to review/study the subject?	Useless at all/Not enough useful	6%
	Neither useless nor useful	35%
	Useful/Very useful	59%
How difficult was writing the questions by your group?	Very difficult/Difficult	18%
	Neither difficult nor easy	49%
	Easy/Very easy	33%
How difficult was answering the questions of the rest of the groups?	Very difficult/Difficult	26%
	Neither difficult nor easy	54%
	Easy/Very easy	20%
How difficult was evaluating the questions of the rest of the groups?	Very difficult/Difficult	59%
	Neither difficult nor easy	35%
	Easy/Very easy	6%
How much time did your group spend writing your questions in the last competition round?	Less than 30 minutes	22%
	Between 30 minutes and 1 hour	55%
	Between 1 and 1.5 hours	17%
	Between 1.5 and 2 hours	5%
	More than 2 hours	1%
How much time did your group spend answering and evaluating the questions of the rest of the groups in the last competition round?	Less than 30 minutes	3%
	Between 30 minutes and 1 hour	36%
	Between 1 and 1.5 hours	39%
	Between 1.5 and 2 hours	16%
	More than 2 hours	6%

4.3 Final Questionnaire

Once completed all the rounds in the competition, the students filled a mandatory questionnaire, whose questions addressed different aspects of our investigation. Based on such aspects, in this section, we present several tables summarising the provided responses. Unlike the previous questionnaires, this last one was not totally anonymous as we wanted to measure the students' satisfaction relating it to their position in the competition ranking. In the questionnaire, students were requested to identify their group.

Table 2 shows a summary of the responses provided to questions aiming to analyse the social atmosphere of the competition. Since the students freely created the groups, 76% of the participants admitted that they already knew all the members of their groups, and the rest said they knew at least half of their group members. This can lead us to conclude that the proposed activity did not help students to better know their classmates. The social atmosphere was good or very good within and among the groups, independently of the ranking positions of each group.

Although we explicitly asked students how much time they spent to solve the different tasks of each competition round, we included a question in the final questionnaire asking students their opinion about the whole duration of the activity. 59% of the participants said that the activity was neither short nor long, while 29% of them felt the competition was long.

Table 2. Selected response statistics obtained from the final questionnaire about the social atmosphere during the competition.

Question	Answers	Percentage of responses
How many members of your group had participated in an activity like this one?	None/Less than half of the group	82%
	Half of the group	6%
	More than half of the group/All	12%
How was the atmosphere in the group during the activity?	Very bad	0%
	Bad	0%
	Good	53%
	Very good	47%
How was the atmosphere among the groups during the activity?	Very bad	0%
	Bad	6%
	Good	76%
	Very good	18%

Table 3 shows a summary of the responses given by the students about their motivation and enjoyment in the competition. It can be seen that this issue was the Achilles' heel of our proposal. Only 18% of the students really enjoyed the activity, while 41% of them said they neither liked nor disliked it. As explained in Section 2, we attempted to design a "healthy" competition following three principles: offering a symbolic prize, having a short duration, and focusing on the (learning) process rather than on the goal. However, it seems we did not put enough effort into the satisfaction of the students' fun and enjoyment needs. As future work, the used Web system based on online forms may be replaced by or enhanced with more sophisticated and attractive e-learning tools, and alternative gaming and competition schemas could be investigated.

Another interesting result can also be observed in the table: the main motivation of 47% of the students to continue participating was the pride of being first. This observation coincides with the conclusion derived from (Siddiqui, Khan & Katar, 2007) regarding the high sense of competition existing among students.

Table 3. Response statistics obtained from the final questionnaire about the students' motivation and enjoyment in the competition.

Question	Answers	Percentage of responses
What was your main motivation during this activity?	The surprise prize	18%
	Reviewing and studying the subject	29%
	The pride of being first	47%
	Gaining recognition from my classmates	0%
	Other	6%
How much did you enjoy this activity?	Not at all	6%
	A little	35%
	Neither a little nor much	41%
	Quite	18%
	Much	0%

In the form, we included questions that were driven to measure differences between preferences for cooperative and competitive learning environments. We attempted to ask for motivation, satisfaction and utility aspects of such environments. A very interesting observation is obtained from the responses. 94% of the students opined that making cooperative activities is a good idea for the subject, while 71% were in favour of competitive activities. However, only 59% of the students were motivated by the fact of working in group, while 70% of them were more motivated by participating in a competition. This is somehow consistent with the results shown in Table 3. In addition, there were no people who thought that working in groups was a bad idea; and there were also no strong opinions against making a competitive activity.

Finally, Table 4 shows a summary of the responses given to opinion questions about the utility of the competition. In general, students felt the proposed activity was useful to study the subject. Moreover, despite their desire to have more fun, 82% of the participants would recommend repeating the competition next year.

Table 4. Some response statistics obtained from the final questionnaire about the utility of the competition.

Question	Answers	Percentage of responses
Would you recommend this activity to be done next year?	No	18%
	Yes	82%
What is the main value or utility of this activity?	Studying the subject in advance	77%
	Working in a cooperative environment	18%
	Working in a competitive environment	5%
How useful this activity has been for you to study the subject?	Not at all	0%
	A little	29%
	Quite	71%
	Much	0%

We analysed the results presented in this section taking into account the ranking positions of the groups in order to detect biases between winners and losers' opinions. We did not find any significant difference between groups with low and high scores, so we can conclude that we achieved our goal of implementing a healthy competition where all participants have no stress, are aware of the real learning value of the process, and feel they have chances to win.

5. DISCUSSION

In this section, we summarise and discuss the results obtained from the different questionnaires that students filled in during the activity.

Utility. We can conclude that the proposed activity was beneficial for the students. 71% of the participants admitted that the activity was quite useful, since it made them to review and study the subject in advance, before the final exams. In contrast, only 29% of the participants stated in the questionnaires that their main motivation in the competition was the study of the subject. 18% of them said that the prize was their most important motivation, and, surprisingly, 47% claimed that they were putting an extra effort in the activity because of their proud of being first in the competition.

Duration. We achieved our goal of designing a not too long activity. 77% of the participants spent less than 1 hour per round to write their group questions, and 81% of the participants spent less than 1.5 hours to answer and evaluate the questions of the rest of the groups. In the final questionnaire, 71% of the participants said the activity was neither short nor long.

Difficulty. In general, students felt the activity tasks were not difficult. The percentages of students who said writing and answering questions were not difficult tasks were respectively 82% and 64%. In the question evaluation task, the percentage was much lower, 41%. The students commented to the teacher that this was due to the fact that the evaluation criteria were not clear in the first round of the competition.

Social atmosphere. Most of the students agreed there was a good social atmosphere within and among the groups. In general, the activity did not help to make students know each other better. This is an understandable issue since most of the students (88%) already knew several or all of the classmates in their respective groups.

Cooperative environment. The students evaluated the cooperative aspects of the activity very positively. 94% of them stated that working in groups is a good idea to review the topics of a subject, and address and solve individual doubts and problems about the studied contents. The use of a simple Web system where everyone can upload and share contents was also one of the issues best appreciated by the students, as reported in their questionnaire responses. In fact, 59% of the students said that this kind of system was a major stimulus. 35% of them said it was indifferent for their motivation and interests.

Competitive environment. The students also evaluated competition positively. In this case, 71% (much less than 94%) of them stated that a (team) competitive environment is useful for the learning process. However, differently to the opinions given about working in a cooperative environment, 70% of the students were motivated by the fact of participating in a competition, whereas 24% said that they felt indifferent about this issue. These results allow us to conclude that our hypothesis is valid, and a healthy competition (as described before) motivates students and enhance their learning skills.

From the questionnaire answers, we identified two limitations in our approach. First, several students noticed that there were “too many” very similar questions. The students were free to decide the topics of their questions, and different groups introduced in the system questions covering the same topic. Second, we received comments about the “improvable” enjoyment of the activity. Although students appreciated the use of an online e-learning system, they recommended us not to use a form based paradigm, and propose a more attractive interface to increase the fun in the competition.

6. CONCLUSIONS AND FUTURE WORK

In this paper, we hypothesise and empirically demonstrate in a study with 77 students that a competition in an e-learning environment can be beneficial if it is designed following a number of principles, such as having a symbolic or little value prize, a short duration, and a goal clearly set into the (learning) process instead of into the results.

In this context, as a result of our study, we also identify the students’ enjoyment as an additional feature to take into account. Thus, the proposed activity should be enhanced with strategies that allow participants to have more fun. We validated our hypothesis by using an Web system based on online forms. However, more sophisticated and attractive e-learning tools, and other types of competitions have to be investigated to address the identified limitation. The idea of competition is usually linked to gaming, and games are often pleasing for any kind of student. As done for example in (Becker, 2001; Chang et al., 2003; Philpot et al., 2005), we plan to study how to incorporate gaming elements into the learning process.

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