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Multi-faceted Impact of a Team Game Tournament on the Ability of the Learners to Engage and Develop their Own Critical Skill Set

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The purpose of the work presented in this paper is helping students to improve and accelerate their learning through a form of cooperative learning known as Team Game Tournament (TGT). The principle behind TGT is that the success of a team lies on the success of the individuals composing the team. TGT enhances learning via the establishment of a tournament where the class is divided into small academically balanced teams that play against each other. Facilitator's notes from visual monitoring, data from student questionnaire and exam results are collected for two structures-related modules of civil engineering stages 3 and 4 with and without TGT. Students show to be focused and participative, to develop their critical thinking and social skills and no less importantly, to enjoy the new learning format. These perceptions are confirmed by student feedback and a significant improvement in their performance at the exam. Student's learning is considerably strengthened by being held individually accountable for formulating and answering questions that contribute to the team score in a TGT style. Team mates help each other and study more than individually because they care for them and for the team.

Keywords: Cooperative Learning, Teaching Methods, Student Attitudes

1. Introduction

The role of the civil engineer in society covers basic aspects such as housing, transport, water resources and environmental quality. Civil engineers intervene in the modelling, analysis, design, assessment and construction of the infrastructure resources that are necessary to look after the society and the environment. In addition to the

latter, civil engineers are able to produce positive changes in the health, safety and productivity of both public and private sectors. With this in mind, accreditation agencies, professional bodies, Higher Education institutions and Ministries of Education have established a framework to define the learning outcomes to be met by an engineering graduate [1]. In recent years, the means to deliver that framework have experienced many changes as a result of fast technological and societal changes [2], most notably, modularisation. Modularisation and semesterisation have eliminated end-of-year examinations and distributed student workload more evenly throughout the year, they have brought a Credit Transfer System and the opportunity for the student to study abroad, to freely choose a number of subjects or to move forward carrying subjects. However, critics of the modularisation system claim that it can bring over assessment and a substantial workload and stress to the student, that learning is fragmented and that students enter examinations when not ready. In this regard, the authors have noticed a drop in average performance in structural-related civil engineering subjects in the transition from a linear to a modular system, which can be attributed to the relative immaturity or narrow experience of the subject [3], i.e., skills that need to be developed over a period of consolidation of knowledge are not present at the time of the final assessment.

A reflection on how to correct some of these issues is the driver for the implementation of a new learning method in two traditionally difficult subjects within the Civil Engineering Programme: “Elasticity and Plasticity (CVEN30150)” and “Structural Analysis, Design and Specification (CVEN40150)” which are 3rd and 4th level modules respectively. In doing so, it cannot be ignored that in real-life, most of civil engineering structural projects are carried out in teams. In regard to the latter, Johnson et al [4] point out: “*Many students do not understand how to work cooperatively with others. The culture and reward systems of our society are oriented toward competitive and individualistic work.*”

Therefore, it is important for the new learning method to provide the student with an ability to efficiently work as part of a team in addition to facilitate an early and thorough grasp of concepts. Cooperative Learning (CL) is chosen as the mean to optimize the way students attain their learning outcomes through team activities. Advocates of CL argue that not only students learn the material better due to the facility to share their knowledge and discuss it within the team, but also foster a more social and cooperative behaviour. This paper discusses the implementation of a novel CL method as part of the continuous assessment in CVEN30150 and CVEN40150. Then, it describes facilitator and students’ views on its potential to improve Civil Engineering Education, and finally it evaluates the impact on the end-of-semester examination results.

2. A Review of Cooperative Learning

CL is an instructional method in which students work in small groups to help each other learn. The Education Resources Information Center (ERIC) database contains 2037 publications on CL between 1966 and 2010, from which 965 relate to Higher Education, 256 to Postsecondary Education, 203 to Elementary Education, 148 to Elementary Secondary Education, 113 to High Schools, 109 to Secondary Education, 104 to Middle Schools and 45 to Adult Education [5]. CL theory has become increasingly popular in recent years, as it shows that only in 2010 the ERIC database contains 326 publications on CL.

2.1. Requirements and Benefits

For a group work to be considered CL, it needs to contain the following five elements [6, 7]:

- *Positive Interdependence*: Perception that each group member is linked to others in a way so that a group member cannot succeed unless others do.
- *Individual and Group Accountability*: Each member must contribute to the group and be accountable for helping the group reach its goals. The performance of each student is assessed and the results are given back to the group and the individual.
- *Face to Face Promotion Interaction*: Each group member promotes each other's success by helping, assisting, supporting, encouraging, and praising each other's efforts to achieve.
- *Social Skills*: Each group member must be motivated, provide effective leadership, be able to make decisions, to build trust, to communicate and to manage conflict, etc.
- *Group Processing*: Group members openly discuss how well they are achieving their goals and maintain effective working relationships.

Two additional elements [5] can be added to the list above:

- *Heterogeneous Groups*: Group members compose a heterogeneous mix.
- *Equal Opportunities for Success*: Students contribute to their groups by improving over their past performance, so the contributions of all group members are valued.

Slavin [8] and Abrami and Chambers [9] underline how researchers agree on the benefits of CL on student achievement, and distinguish four major theoretical perspectives to explain the achievement effects of CL:

motivational perspectives, social cohesion perspectives, cognitive developmental perspectives and cognitive elaboration perspectives. In another words, the students participate more actively and are more successful because:

- they are rewarded when the group is successful [10],
- they care about the others and the team,
- their peer interaction is further enhanced [11] and
- they get to understand the material better by explaining it to others.

More specifically, Slavin suggests that CL is a great learning tool for students with disabilities, which facilitates their integration in a working environment. Other researchers also report how students using CL are willing to make more questions to the facilitator, like the material and institution better [12], are more likely to make friends and like and trust other students and have more self-esteem than in traditional classes [13].

2.2. Types

Slavin [14] distinguishes two broad categories within CL: “*Informal Group Learning Methods*” and “*Structured Team Learning*”. The first category is more focused on social dynamics, projects and discussion than on well-specified content, and the second category involves rewards to teams based on the learning progress of their members. *Jigsaw* is a method falling into the first category, where students work in teams on academic material broken into sections. The main four methods falling within the second category are: *Student Teams-Achievement Divisions* (STAD), *Teams-Games-Tournament* (TGT), *Team Assisted Individualisation* (TAI) and *Co-operative Integrated Reading Composition* (CIRC). While STAD and TGT are adaptable to most subjects and grade levels, TAI and CIRC are designed for use in mathematics and reading/writing instruction respectively. In both STAD and TGT, students work together to learn and are responsible for their teammates learning as well as their own but they are distinguished by the way their learning is tested: through individual quizzes in STAD and through competitions between the teams in TGT. TGT is the preferred form of CL chosen to be implemented in CVEN30150 and CVEN40150 due to their contents and other reasons that will be unfolded further on.

TGT was developed by DeVries & Edwards in the early 70’s [15-17]. It aims to promote learning by dividing the class into teams which play against each other, and it has been employed in Schools at all grade levels. A traditional way of applying TGT consists of forming the teams according to the academic ranking of

the members, so that the teams are balanced in average performance. Then, each member of a team sits in a different table (according to the academic ranking) meeting other members of other teams of similar ranking [18-21]. The facilitator has a number of questions/answers (typically in a card format) prepared for each table. In each table, one of the students reads the question, and the other students can “pass” or “challenge” the question. If a student that has challenged the question gets the answer right, he gets a score that will add up to his/her individual score and that of his/her team. The student to read the question and check the answer is changed for every new question. Given the nature of the material in CVEN30150 and CVEN40150 where calculations are required and answers cannot be immediate, such a traditional pass-challenge TGT approach would not be feasible and a number of novelties are incorporated to suit time constraints and allow participation of all students.

2.3. Past Research

A thorough review of research on CL can be found in [5, 8, 13, 22-24]. At School levels, statistics reveal CL classes achieve significantly higher test scores than conventional teaching [25]. Other researchers have confirmed these positive results in different subject scenarios: algebra [26], geometry [27] and maths [28, 29]. However, it must be noticed there may be conditions where the advantages of CL over individual learning are not so clear (i.e., results of an instruction by television using a systematic approach [30]). CL has been reported to almost always improve affective outcomes, although, to also largely depend on elements such as group goals and individual accountability for successful achievement outcomes. Researchers acknowledge the need for testing CL in new conditions, for which group goals and individual accountability may be or may not be effective. So, Abrami and Chambers [9] build on Slavin’s research to analyse the effects of group failure, how should students be grouped and how curriculum should be designed for CL. Further on, Johnson et al [23] compare eight methods of CL based on 164 studies and find the more conceptual approaches to CL may produce higher achievement and are more robust, adaptable to changing circumstances and easier to maintain than direct methods, although the latter are easier to learn and apply in class initially. They weigh the overall performance of CL methods according to their direct-conceptual nature, with TGT scoring somewhat higher than STAD, CIRC and TAI.

At Higher Education level, Johnson, Johnson and Smith [4] report over 168 studies conducted between 1924 and 1997 on the substantial increase in achievements of individuals 18 years or older when using CL compared to competitive and individualistic learning. For example, students scoring at 53rd percentile level

when learning individualistically scored at the 70th percentile when learning cooperatively. Prince [31] provides measures of improvements due to CL and active, collaborative and problem-based learning methods using effect sizes (defined as the difference in the means of a subject and control population divided by the pooled standard deviation of the populations) reported in the literature. He warns the reader of the practical limitations of these values which are, on average, for the populations examined and are intended to help facilitators “*go with the odds*”. Felder and Brent [32] describe CL methods that specifically address the following engineering outcomes: (a) apply knowledge of mathematics, science; (b) design and conduct experiments, analyse and interpret data; (c) design a system, component, or process; (d) function on multidisciplinary teams; (e) identify, formulate, and solve engineering problems; (f) understand professional and ethical responsibility; (g) communicate effectively; (h) understand impact of engineering solutions in a global/societal context); (i) recognize need for and be able to engage in lifelong learning; (j) know contemporary issues, and (k) use modern engineering techniques, skills, and tools. Felder et al [33] compare a population of chemical engineers trained in active and cooperative learning, to a second population trained in traditional individualistic learning during five consecutive semesters. They conclude that the first population have a higher retention in the chemical engineering curriculum, develop higher critical skill levels, better peer-interactions, improved performance in tests and more positive attitudes toward their instruction, although they acknowledge the second population presents a higher ability to work independently. Similarly, Hsiung [34] compares performance of two populations of mechanical engineers and notices that CL is less effective than individualistic learning in the early stages of team development. The need for a substantial amount of time to take advantage of the strengths of team members and overcome their weaknesses is also emphasized by Trytten [35]. Othman et al [36] evaluates CL in two stages of engineering mathematical courses, and conclude the impact of CL is more significant with more matured students. They also acknowledge that CL can create considerable difficulties to the facilitators and may not accomplish automatic benefits if it is not appropriately implemented. Robinson [37] adds that CL can lack attention on academically talented students. Scott and Yates [38] investigate 20 engineers during the first years after graduation (including a range of disciplines: civil, mechanical, electrical, environmental...) qualified as high-performers by their work supervisor. Their investigation ranks capabilities within the ‘emotional intelligent’ category (i.e., *being able to contribute positively to team-based projects*) as the most important for success, preceding other ‘profession-specific’, ‘generic skills and knowledge’, ‘intellectual capability’ and ‘educational quality’ categories. Ahern [39] feels that the usefulness of team-based projects or group work is not maximized in civil engineering courses, but could be improved if lecturers were trained in CL. Smith et al [40] reviews classroom-based

pedagogies of engagement, particularly cooperative and problem-based learning, and they pose many unanswered questions about the efficacy of these pedagogies including: “*Can group-based methods have a negative effect on individual skills? Is there an optimum balance between group and individual work? Can the effects of the individual criteria that define CL be parsed out to determine which are the most and least important?*” Clearly, further research is needed to measure the effectiveness of CL. More specifically, this paper will investigate if TGT can be successfully implemented in a civil engineering context. In this process, the authors will provide TGT the character of a ‘serious game’ that will aim for high levels of engagement achieved by adolescents during active leisure activities, games and sports [41].

3. Method

3.1. Setting and Participants

A TGT is implemented within two civil engineering modules at University College Dublin (UCD, Ireland): CVEN30150 (3rd stage) and CVEN40150 (4th stage), which bring together analysis and design within structural engineering. They are core modules that target three degrees: Civil Engineering, Structural Engineering with Architecture, and Science Engineering. In the academic season 2013/14, there are 30 and 27 students registered in CVEN30150 and CVEN40150 respectively. The learning outcomes of CVEN30150 that will be covered by TGT are as follows:

- Formulate stress and strain tensors and vectors, and determine all possible states of stress and strain in a point using an algebraic form or Mohr's circle.
- Apply small deformation theory to obtain displacements, strains and stresses using the kinematic, constitutive, compatibility equations and differential equations of equilibrium.
- Analyse stress, strain and failure in deformable solids under the action of external forces, with emphasis on combined stress states, plane stress and plane strain problems.

Following the module descriptor, CVEN30150 is learnt via 36 lecture-hours, 6 tutorial-hours, 4 computer lab-hours and 70 hours of autonomous student learning. TGT is introduced here within the 6 tutorial-hours.

The learning outcomes covered in CVEN40150 are:

- Interpret the origin and nature of the tools and concepts of concrete design such as interaction diagrams and plastic moment redistribution.
- Design reinforced and prestressed concrete beams, columns, frames and slabs.
- Design masonry structural elements.

CVEN40150 is learnt via 30 lecture-hours, 70 hours of autonomous student learning and 10 tutorial-hours that facilitate practise and complement the lectures. Again, TGT is introduced here within the tutorial-hours.

In past seasons, tutorials have had a traditional format consisting of one or a few questions that students had to solve and submit at the end of a 2-hour session. The questions were common to all students, related to the material imparted in lectures at the time and they were made available online a few days before the tutorial so students could familiarize with them. During the two hours, the students worked in groups (that they chose freely), helped each other and also obtained help from the facilitator as requested. About one week after the tutorial, students would get the corrected solutions with annotations and their score (which counted towards their continuous assessment). In the feedback at the end of the semester, students pointed at the tutorials as the module component that impacted their learning most. While doing the tutorials, they were able to identify what they do and don't understand, and could ask for help if stuck in their learning process. While the feedback was positive overall, the level of student engagement and participation were very diverse, and the tutorial component is remodelled here using TGT to further motivate, stimulate and enhance the students' learning.

3.2. Objectives

The main objectives of the TGT are:

- To allow students to practise the material imparted in lectures and bring early awareness of potential difficulties,
- To emphasize and meet learning outcomes (which the facilitator aligns with team goals when providing the rules for defining the questions),
- To encourage all students to learn and achieve the learning outcomes if they want their team to succeed. Given that "higher individual score = better team score", students will like to contribute to the team and work harder.

- To strengthen the role of the student as a team player, as students will help one another to improve the team performance,
- To make the learning experience more enjoyable, given that students will see learning as ‘social’ instead of ‘isolated’.

3.3. Implementation

Two popular formulae employed in tutorials are traditional problem-solving and problem-based-learning. Both formulae present a problem to the student, defined either well-structured as a direct application of the knowledge provided in lectures, hand-outs, etc., or ill-conditioned as incomplete information that requires further analysis/research. A different approach is adopted here: the student, as part of a team, will be the one formulating and taking ownership of the question. The motivation behind this approach is to deepen the student’s awareness of the learning outcomes, to encourage their engagement and to lead them to an overall increase in the sense of ownership of the learning process. An extra motivation is the possibility of impressing their peers and improving the performance of their team in the tournament. The posing of questions formulated by students to other students has been tested successfully before, leading to more critical thinking and higher achievement than students using a traditional discussion approach [42]. A TGT is organised to facilitate sharing of those questions among students as follows:

- (1) The facilitator introduces the topic in lectures. This introduction lays the basis for the partial or full accomplishment of a learning outcome.
- (2) Students work in small teams to prepare questions and their answers related to the topic and in agreement with specific guidelines provided by the facilitator that aim to meet the learning outcome.
- (3) Students answer questions proposed by other team.
- (4) Students are assigned scores according to their individual performance (quality of proposed questions and accuracy of answers) and their team performance (based on how their answers compared to answers by other team).

The CL context above intends to develop a sense of social cohesion and social responsibility for each other’s learning featured in structured groups [29]. TGT regulations are explained in a lecture prior to the first session and made available online via blackboard. These regulations are summarized in the sections that follow.

3.4. Structure of the Activity

3.4.1. Team Composition

Students carry out their continuous assessment component in a specific team to which they belong for the module. Here, the teams are small and academically balanced based on performance in the previous year. Results from the same students in 2nd year Mechanics of Solids (for CVEN30150 teams) and 3rd year Analysis of Structures (for CVEN40150 teams), both related subjects, are used as reference. CVEN30150 and CVEN40150 have a similar class size of about 30 students. Therefore, six teams of 4 or 5 students are formed: Four of these teams are heterogeneous regarding the academic background while two teams are mostly composed by Structural Engineering with Architecture students or Civil Engineering students for comparison purposes. Each team nominates a captain who is responsible for collecting and delivering questions and answers from the team at the end of each hour. Other responsibilities of the captain include making sure info provided by the team members is complete and talk to the facilitator in case of conflict with a question (i.e., incomplete or unsuitable) or match result.

3.4.2. The Tournament

The TGT consists of three matches (24th October, 7th and 21st November for CVEN30150, and 27th September, 1st November and 22nd November for CVEN40150). The duration of each match is 2 hours. The pairing for the 1st match is drawn at random. Ideally all teams would have faced each other once, but due to time constraints (more teams than available time slots for matches), the remaining matches are established according to the Swiss pairing system. In the Swiss system, winners are pitted against winners, losers are pitted against losers, and so on. This arrangement is in the spirit of CL where teams must be evenly matched according to academic strength. In subsequent matches, each team faces an opponent with the same, or almost the same points. No team is paired up with the same opponent twice. A win counts as 3 points, a draw as 1 point and no points are granted for a loss towards the general classification. In the final classification, the teams are ranked according to the points accumulated across all their matches.

3.4.3. Organisation of a 2-hr Match Session

The tables in the project room are organised in such a way that the members of each team can sit together and separated from other teams. Initially, the facilitator provides a hand-out with the requirements for the question/s deemed to be suitable for the match, typically related to specific learning outcomes being dealt with at lectures. For the last match where final rankings will be decided, the entire syllabus is reviewed, and questions meeting any of the learning outcomes are accepted.

During the 1st hour, each team member must prepare his/her own question and the answer to that question. Different pages must be submitted for the question and for the answer, labelled with the student's and team's name at the top of each first page. The total number of questions produced by each team is equal to the number of members of the team. In this way, it is ensured everybody participates and the question is solvable within the allocated time. Students are allowed to take as reference examples available in lectures but they will be penalised if using too similar parameters or asking for something trivial. The more creative and original the question, the higher mark they will get. The use of external sources such as books or web-based resources during the match is strictly forbidden to ensure a fair competition (i.e., all students must use the same basic means: lecture notes and course material available online). Although team mates should give priority to their own question, they can help each other for this task.

At the end of the 1st hour, the team captain collects questions and answers by all students to forward them to the facilitator. Following a short break (at which the facilitator separates and stores the answers of the 1st hour), the proposed questions are distributed to the members of the opponent team (according to the draw). In case of unbalanced number of players between two teams, two players are asked to answer the same question. Each team is then given one hour to provide answers (as many as team members). At the end of the 2nd hour, the facilitator collects all questions and answers.

3.4.4. How to Decide the Outcome of a Match between 2 Teams

For a game between two teams with 5 members each, there will be a total of 10 questions and 20 answers. For each question, the original answer and the answer by the opponent team are compared. If both answers are equally good or equally poor, none of the two students will score for their team. However, if one student provided a better answer than the other, that best answer is granted a 'goal' for his/her team. By adding the scores of all questions, the final outcome of a match (a win, a draw or a loss) is established.

3.5. Structure of the Reward

The student achievement is largely dependent on the structure of the reward which needs to be carefully defined at the start of the tournament. The assessment of CVEN30150 and CVEN40150 is distributed between an 80% end-of-semester examination and 20% continuous assessment. In this academic season, TGT has taken over the 20% continuous assessment component of CVEN40150 which has been weighed as follows: 20% for participation, 20% for the level of reflection and complexity associated to the formulated question, 20% for the accuracy, clarity and understanding of the answer to the proposed question, 20% for the answer to the question proposed by the opponent team and 20% for the team performance. The team performance is quantified as 20%, 10% and 0% for a match win, draw and loss respectively. The champion and runner-up of the tournament are rewarded with an additional 5% and 2% respectively on their team average performance. Therefore, each member of the winning team is awarded a trophy sponsored by the School to promote students taking one another's achievement seriously. In the case of CVEN30150, there is also a 20% continuous assessment, although the latter is shared between computer labs (10%) and tutorials (10%). Here, TGT takes over the 10% attributed to the tutorial component which is distributed using the same criteria as for CVEN40150 above.

The percentage distribution between individual (80%) and team (20%) performance attempts to address the argument by Slavin [7] who finds “*cooperative learning has its greatest effects on student learning when groups are recognized or rewarded based on the individual learning of their group members*” without being too detrimental for the grade of academically talented students that may fall victims to a less cooperative/capable team [37].

3.6. Roles of the Facilitator

The roles of the facilitator include:

- To provide a prior knowledge in lectures that serves the basis for the topic to be dealt with in the respective matches.
- To get the tournament started, to establish and to clarify rules and concepts.
- To contribute to integrate members of each team, promote participation and commitment and relieve any strain within or between teams.
- To encourage and support teams and act as a source of information available to the students.

- To act as a referee during the game, i.e., to decide if a question is valid or not. A significant difference with other approaches is that questions are proposed by the students, which can lead to a number of conflicts such as the possibility of the question being unclear, incomplete, inappropriate or not achievable within the allocated time.
- To decide the outcome of a match, i.e., if an answer by a team is better, equal or worse than the answer by a second team. The facilitator will judge questions and answers on the basis of clarity, complexity, and level of understanding and reflection. In this process, it will become possible to compare the student's perception of what is important and what is not, to that of the facilitator. The facilitator will be able to evaluate if the right thing has been transmitted.
- To provide feedback to the teams. Selected games including questions and corrected answers (signalling typical errors) will be scanned and uploaded online and discussed in lectures. Only the names of those students that score are revealed to emphasize their contribution to the team.
- To keep accurate and periodic records of individual performances.
- To recognize team scores in form of an updated classification table. Following a match, the table is uploaded and made available online and eventually reported in lectures.

4. Data Collection

An anonymous student questionnaire has been used to measure student's satisfaction via a Likert scale. The mean Likert values are on a scale of 1 to 5 where 5 is 'Strongly Agree'. This means that higher values equate to greater satisfaction. Answers to these questionnaires have been gathered for 21 CVEN30150 students and 23 CVEN40150 students on the 13th and 15th November respectively. The questions are directly related to the objectives outlined in section 3.2, and the percentage number of hits for each response is illustrated in Fig. 1.

While in 2012 students were subject to a standard traditional tutorial format, in 2013 they have been exposed to the TGT format subject of this investigation. From observation of the running of TGT sessions and correction of questions, the facilitator reports on a number of differences with respect to traditional tutorials in the previous season. Exam marks are also compared for 2012 and 2013 populations. The duration of the end-of-semester examination was 2 hours for both modules. There were 31 and 28 students sitting at the CVEN30150 exam in 2012 and 2013 respectively. For CVEN40150, there were 31 students taking the exam in 2012 and 23 students in 2013.

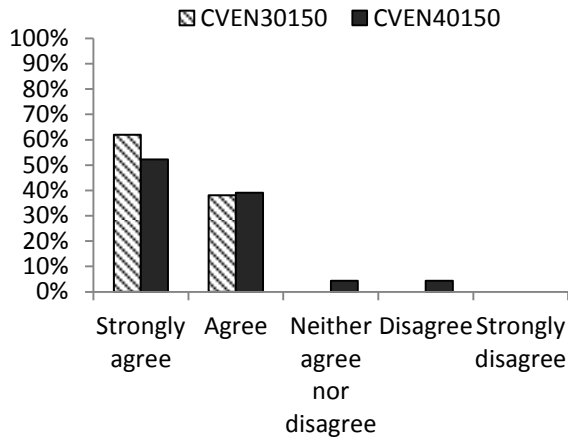
There are limitations to the potential generalization of this study beyond the context (namely a Civil

Engineering School in Ireland) and the sample (Four small populations of about 30 students each from structures-related modules) employed here. Each student population is distinguished from each other by the module (CVEN30150/CVEN40150) and/or by the learning technique (traditional/TGT). The players of the TGT teams are selected based on their ranking in a module of similar nature in the previous academic season; however, a standardized test could improve their academic classification and team balance. The TGT consists of three matches, when a higher number would have been desirable. As mentioned in section 3.1, number and distribution of hours between lectures and tutorials have not changed between 2012 and 2013 for any of the modules, but it must be pointed out that one of the two lecturers of CVEN40150 have changed (the two lecturers in CVEN30150 have remained the same in both years). Each learning technique is tested in a different year, i.e., 2012 and 2013 cohorts are used as control (traditional individualistic learning) and test (TGT) populations respectively. The populations taking the CVEN30150 exam have similar dimensions in both years, however the CVEN40150 population taking the exam in 2013 is 25.8% smaller than in 2012. Even though exams in these two years are deemed to be comparable in level of difficulty and achievement of learning outcomes signalled in section 3.1, they are not identical given the existence of archives of past examinations. Finally, there is feedback on student's perceptions in 2013, when the sample is exposed to TGT by the first time and has also experienced frequent traditional learning in the past. Therefore, their positive reactions towards TGT can be partially attributed to its novelty.

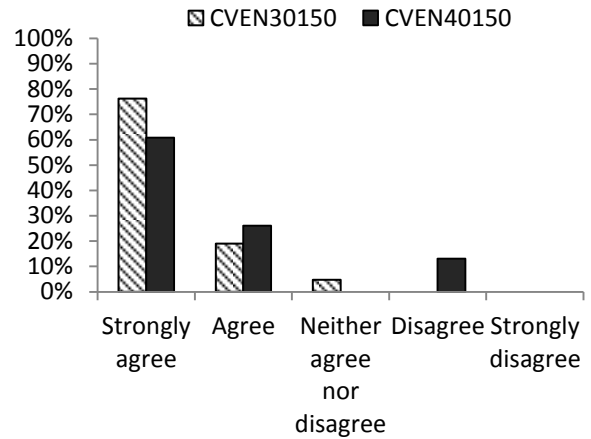
5. Results

5.1. Students' view

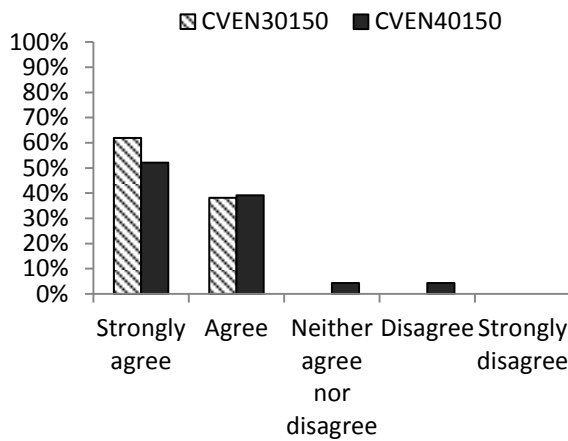
The class in CVEN30150 has a slightly stronger feeling on the benefits of the implemented tutorial than in CVEN40150, i.e., there has not been a single record of disagreement on the targeted questions (Fig. 1). Both classes prefer "strongly agree" to "agree" in 5 out of the 8 questions. The three questions where "strongly agree" is not clearly dominant over "agree" are related to group relationships such the degree of help by/to other team mates and the links established among them. This could be somehow related to the fact that students were exposed to only two matches when providing the feedback.



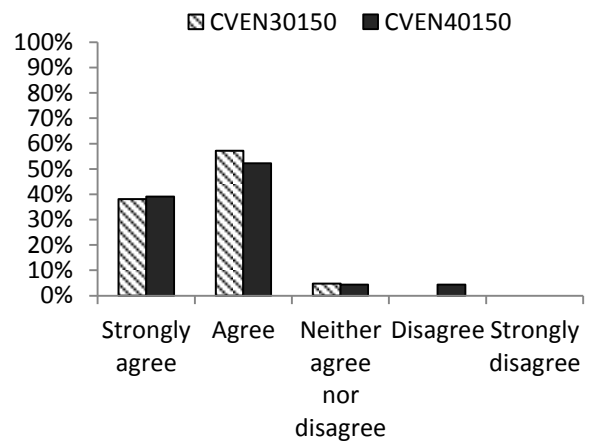
(a) The new tutorial format is efficient in allowing me to practice the material taught in lectures



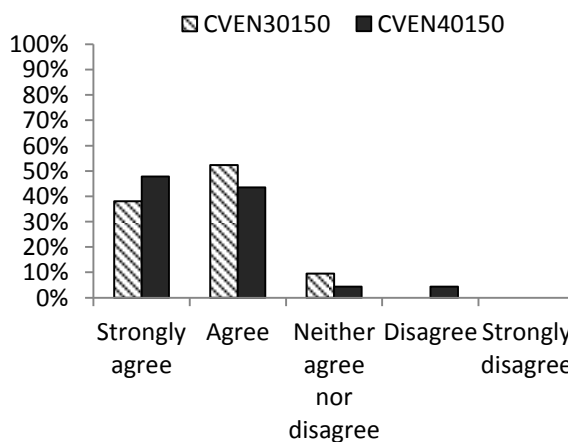
(b) Defining questions and answers and solving other team's questions let me reflect on the topic and makes me aware of what I must revise/reinforce.



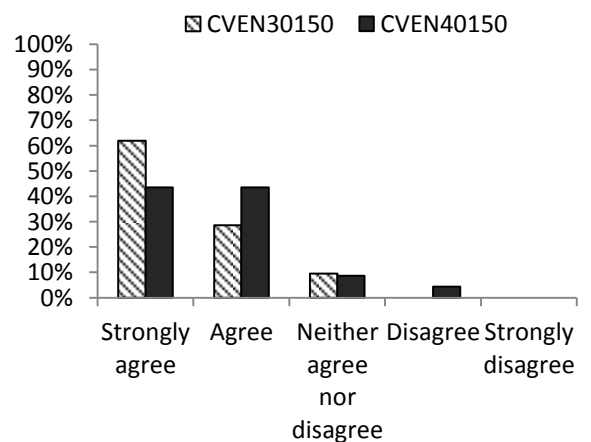
(c) I work harder to improve the score of my team.



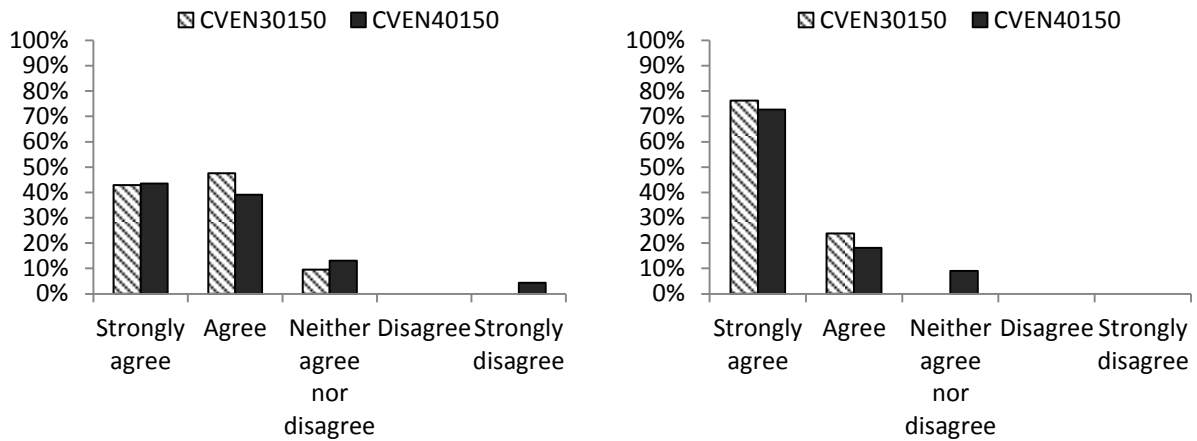
(d) I help my team mates during or for the games.



(e) I am provided assistance by my team mates during or for the games.



(f) I enjoy participating in the tournament.



(g) My links with my peers are being strengthened during the tournament.

(h) Overall I recommend using this tutorial format in the future.

Fig. 1. Student feedback on Questionnaire

If the categories “Strongly agree”, “Agree”, “Neither agree nor disagree”, “Disagree” and “Strongly disagree” are weighed 5, 4, 3, 2 and 1 respectively, it is possible to obtain a mean and standard deviation per question that allows meaningful comparison of the degree of fulfilment of each objective. These values are provided in Table 1. For both classes, the response with a highest score is (h) recommending the use of this format in the future. Also for both classes, questions (a) and (b) associated to knowledge (i.e., practise and reflection on the topic) follow in this ranking of responses with highest positive impact. Students in CVEN30150 appear to have enjoyed more than in CVEN40150 according to (f). The author believes the latter has influenced the score in other questions involving helping other mates (d), being helped by other mates (e) or strengthening links with peers (g) where CVEN30150 has also scored higher than CVEN40150. The standard deviation of the responses in CVEN40150 is slightly but consistently higher than in CVEN30150.

The questionnaire also allowed students to include open comments in their feedback. In their own words, they find tutorials to be ‘helpful’, ‘good fun’, ‘different’, ‘interesting’, ‘challenging’ and ‘exciting’ and ‘to make the outcomes easier to learn’. They also appreciate to bring a team competition in the process which they acknowledge ‘it has made them work harder’.

A new component they have weighed positively is the nature of having two elements to the tutorial: one for the preparation of their own questions and answers, and another to answer the opponent’s questions. They believe this has helped them to build their confidence and to feel they have done their best. They point out

that it is a great way to improve their study as it sets a goal to aim for. Suggestions by students include incorporating more matches, to make them more spread throughout the year, to allow more time between the material imparted in lectures and the related match, and to add new features to the competition such as a mid-season transfer window.

Table 1. Mean and Standard Deviation of the Responses (maximum 5 -strongly agree- and minimum 1 -strongly disagree-)

QUESTION	CVEN30150		CVEN40150	
	Mean	St. Dev.	Mean	St. Dev.
(a) The new tutorial format is efficient in allowing me to practice the material taught in lectures	4.61	0.49	4.39	0.77
(b) Defining questions and answers and solving other team's questions let me reflect on the topic and makes me aware of what I must revise/reinforce.	4.71	0.55	4.35	1.00
(c) I work harder to improve the score of my team.	4.33	0.56	4.35	0.63
(d) I help my team mates during or for the games.	4.33	0.56	4.26	0.73
(e) I am provided assistance by my team mates during or for the games.	4.29	0.63	4.35	0.76
(f) I enjoy participating in the tournament.	4.52	0.66	4.26	0.79
(g) My links with my peers are being strengthened during the tournament.	4.33	0.64	4.17	0.96
(h) Overall I recommend using this tutorial format in the future.	4.76	0.43	4.64	0.64

5.2. Facilitator's View

Compared to a traditional tutorial format as described before, in the proposed TGT format:

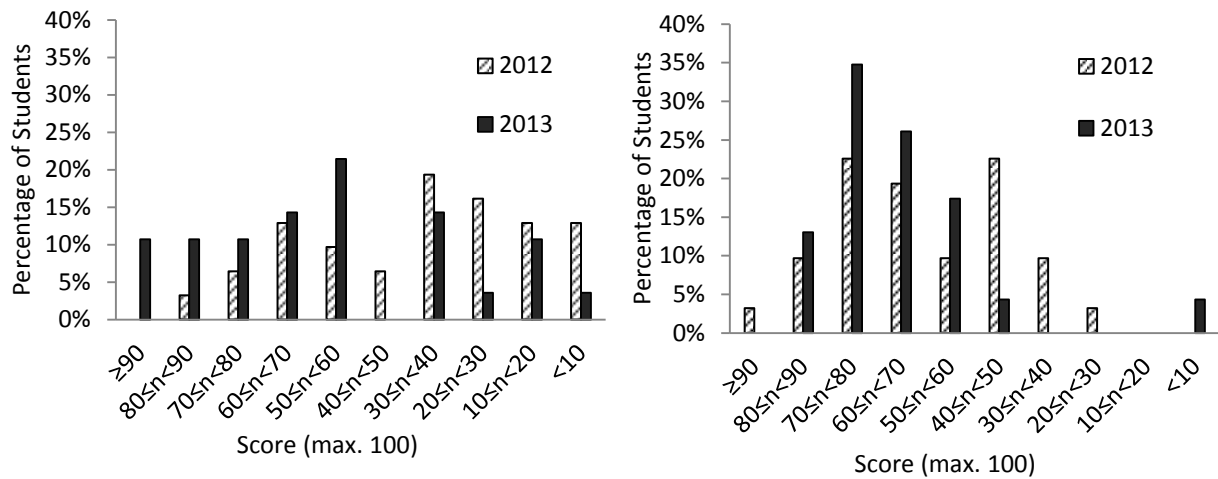
- Students are more focused and interact more. In the 1st match, the facilitator noticed more discussion among the 3rd year' students than the more mature 4th year's, although, overall, students worked rather individually, doing their own thing, without paying too much attention to their team mates. In the 2nd and further matches, the attitude changed, and students shared knowledge with their peers and

supported each other significantly. This is in agreement with previous research that indicates a minimum period of exposure to CL is necessary before becoming efficient in developing critical thinking and social skills [34, 35]. Initially, it could have been thought that those teams composed of only Civil Engineering students or only Structural Engineers with Architecture would perform better than more academically heterogeneous teams given that they knew each other longer and probably worked together in the past. The latter could have been a trigger to experience the positive effects of CL from an early start. However, there was a close competition without a team that clearly stood above the others.

- Students are more enthusiastic and appear to enjoy more themselves. After completing a session they would let us know they were looking forward to the results of the matches or an anecdotic “*Good Game!*” would be pointed by a student to a student of other team. From the 2nd match onwards, students appear relaxed and often make their opponents smile on the challenge they are confronting them with.
- There is a higher level of participation and commitment. All students participate and they do it in an original way, proposing a different question and answer. They do so as they are aware otherwise they or their team will not be rewarded and assessed positively. In traditional tutorials involving group work, the danger of having a reduced number of people doing most of the work is considerably higher.
- A valuable and relatively large database of questions and corrected answers (including typical errors or misconceptions) is generated and made available online to all students. This database is a relative measure of how far critical thinking and level of reflection has been developed compared to other approaches with fixed questions and answers.

5.3. End-of-Semester Examination Results

The improvement in the part of the CVEN30150 exam covered by TGT, which represents half the total exam, has been very significant, going from an average score of 34.8% in 2012 to 54.3% in 2013 (the pass mark is set at 40%). It must be noticed that the average score in the other half of the module where no changes have been implemented, have dropped from 44.8% to 39.5%. Students appear to have shifted their efforts towards the half of the module with TGT. Both halves of the module are equally weighed in the exam, and have led to an overall average mark that has increased from 39.8% in 2012 to 47.7% in 2013. The percentage distribution of marks is shown in Fig. 2(a) for CVEN30150. Fig. 2 only reflects the scores for the half of the exam covered by TGT.



(a) CVEN30150

(b) CVEN40150

Fig. 2. Distribution of Scores in the Exam.

Similar conclusions have been found for CVEN40150. In this case, the average result in the part of the module where TGT has been applied has increased from 59.9% in 2012 (based on 31 students) to 64.5% in 2013 (based on 23 students). There are less number of failures and most of scores concentrate between 60 and 80% (Fig. 2(b)) in contrast to the more uniformly distribution seen in Fig. 2(a). Basically, CVEN30150 is comparatively a more difficult subject for 3rd year students than CVEN40150 is for 4th year students. The part of CVEN40150 without changes have experienced the same undesired effect of poorer performance than in the previous year (decreasing from 45.2% in 2012 to 42.8% in 2013), although to a less extent than in CVEN30150. Overall, the average mark of the entire exam has increased from 52.5% to 57.3%. From these results, it can be concluded a TGT-based format has been far more efficient than a traditional tutorial format in supporting students' learning for the two modules under investigation.

6. Conclusions

A TGT has been implemented within the tutorials of two Civil Engineering modules involving analysis and design of structures. The high expectations established for TGT at the start of the academic season (i.e., to bring more practise, greater and earlier awareness of learning outcomes, extra motivation for students, better team players, and a more enjoyable learning experience) have been met. Students have found competing against

someone while also being able to work as a team in a CL style, an appealing and thrilling idea. They have confirmed via viva voice and questionnaires they have really enjoyed and learned substantially from the new tutorial format. These students' perceptions have been reinforced by a significant improvement in results at the end-of-semester examinations. This paper has shown that an effective implementation of TGT can lead to higher grades and student satisfaction than traditional individualistic learning. However, these results are not guaranteed and they need to be interpreted cautiously taking into account the limitations of the study until more testing is carried out by independent researchers.

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