The Use of Field Trips in the Context of Engineering Collaborative Teaching: Experiences of Hands-On Geomatics Activities in Colombia

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Keywords: Geomatics Education, Field-Trip Approaches, Education Innovation

SUMMARY

Education is not fulfilled until the theoretical concepts learned in the classroom are applied. This becomes particularly important when large quantities of knowledge are to be introduced to students in a short period of time. Geomatics engineering subjects, which combines surveying with information technologies, faces commonly this challenge. A way to accelerate learning processes is the implementation of a field trip in the curriculum. In a field trip students through different activities, apply concepts learned in class and, in the case of Geomatics, have the opportunity of using specialized equipment in a more real context. This paper presents experiences on applying a field trip in an undergraduate introductory course for civil and environmental first year students. By using a control group of students that did not attend the field trip and surveys, it was possible to identify possible impacts of the field trip on student learning. It was found that results were not consistent for areas covered during the field trip. However, it appears that learning the use and data processing of equipment that contain particular setup configuration, did improve significantly with the field trip activities. Further research opportunities exist in exploring field trips as the main learning methodology for Geomatics and doing on-classroom activities that replicate field trip experiences

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1. INTRODUCTION

This paper describes and critically evaluates a field trip activity that has been conducted 4 times with different students as part of the undergraduate Geomatics course, a compulsory subject of the civil and environmental engineering programs at Los Andes University. The course is an introductory and basic course as part of the general engineering core areas. For most students, regardless of their program, Geomatics subject is their first course in surveying techniques and the first time where they learn concepts that have a direct applicability in society. At los Andes, Geomatics introductory subject for engineering has between 100 and 120 students every semester and the subject runs for 14 weeks per semester with an intensity of 3 hours of lecturing and 3 hours of practicals per week.

The Geomatics course at los Andes University includes the study of land surveying, levelling networks and Traverses. It also includes the use of new technologies in surveys such as high precision GPS and the use of Geographic Information Systems for data processing and analysis.

The course includes a field trip. It is a 3-day camping activity in a national park. The main objective of the field trip is to complement topics covered during standard lecturing and practical sections of the course.

Particularly, the field trip aimed to be a collaborative learning experience for the students with three main specific objectives: improving their ability to work in teams, solving real Geomatics problems and having hands-on experiences with multiple equipment and methodologies.

As there were no previous experiences locally of field trips for teaching Geomatics, experiences from other universities were used to design the activities, including the equipment and procedures used.

2. BACKGROUND

Field trips have been used as a complementary activity in different curriculums and at different ages. Field trips create opportunities for students to acquire practical technical skills alongside individual and social experiences (Demirkaya and Atayeter, 2011). Commonly field trips have three types of goals; (i) subject-specific knowledge, (ii) skills of group leadership and communication and (iii) socialization and personal development (Ken and et al, 1997). However, studies have shown a greater emphasis on cognitive and technical aspects (first goal), letting aside the students' emotions on learning (Demirkaya and Atayeter, 2011).

Field trip experiences (the way the knowledge is acquired) have shown a better understanding of knowledge by students when compared to classroom lectures. This is due to the possibility of connecting the knowledge learned in class with personal situations, creating better knowledge retention (Knapp, 2000).

One of the biggest questions after a field trip is what students may be able of remembering after time has passed. To answer this question it is necessary to perform a memory research study related to field trips. Even if information is lacking in this field, some studies have been done in the area, for example Mackenzie and White (1981), Jones and et al (1994) and Cline (1996). In general, the students who participated in a field trip show "less loss of knowledge." (Knapp, 2000), results that justify the administrative, time consumption and financial resources required to conduct a field trip.

In addition to learning retention, Skop (2009) has investigated a critical aspect during the development of a field trip; the cooperation between teachers and students, also called field trip based learning community. Skop (2009) evinces how important this team-work provides thinking in practical, critical and creative directions. And most importantly, it helps break down barriers among teachers, learners, researchers, faculty, etc. In this way, students are not just the recipients of the information but become co-actors, and the teachers co-learners. However, this process requires adaptation and blurring of boundaries to create a sense of community between students and faculty (Skop, 2009).

More specifically for Geomatics and surveying, field trips have been used in many situations. For example the Surveying Engineering Program at the Wilkes-Barre Campus of The Pennsylvania Stet University (Francis W. Derby and Willie Ofosu, 2005). They have found that through the students' discussions with engineers and technicians during the trip and also their conversations with faculty after the trip, there is an obvious indication that the students have gained a lot of knowledge as a result of the field trip. In addition, their desire to go on more program-related field trips demonstrates an increase in their motivation to learn as well as their desire to know more about the technology. Verbal comments from students indicate a better understanding of topics that have been discussed in class. During classroom discussions students are better able to relate the appropriateness of certain courses to engineering applications.

Today the use of virtual field trips has taken great boost, but for this area of knowledge we believe it is more accurate using real field trips for Geomatics as concluded in Weili Qiu and Tom Hubble (2002) virtual field trips have many advantages and can be useful in many aspects in teaching. They are especially good for pre -study and review. Students love field trips because they can learn knowledge and skills while having unforgettable and irreplaceable experiences. The greatest disadvantage of VFTs is that they cannot simulate many of the real sensory aspects of fieldwork and consequently should not ever be used to replace real field trips. Also, a study (C. Arrowsmith, A. Counihan and D. McGreevy, 2005) in which many students simulated a virtual field, for the teaching and learning of geospatial science, was developed at RMIT University, Australia, and they found that whilst the majority of participants found the virtual field trip useful in preparing them for fieldwork, they

experienced some difficulty in navigating the system. All expressed concern that a virtual field trip should not replace actual fieldwork.

3. RESEARCH METHODOLOGY

Based on current literature and experiences and taking experiences from other universities (Wong, A. and Wong, S, 2009), a general design of the field trip was conducted. This design included allocation of time per task as well as key topics to be covered. Next we explain in detailed the process followed to plan and conduct the field trip at Los Andes University. This is provided as a mean to inform other practitioners of the level of effort required in field trips compare to normal classroom activities.

The procedure followed for planning and executing the field trips for the Geomatics course at los Andes University for undergraduate students was:

1. Exploration of possible locations for the field trip and selection of the best place. In this, it was important to ensure that these places provide safety, security and availability for the dates the activities were planned to be.
2. Determine how many days the field trip will take place, which topics were going to be evaluated, its possible activities, and budget. For that, it was taken into consideration that the selected place was appropriate for the different activities that would take place. Also workshops between professors and tutors were conducted to design individual activities, including detailed rules, and marking procedures.
3. Create a schedule of all the activities that were going to take place for three days, and make inventory of the equipment that was needed.
4. Prepare and inform the group of tutors and other volunteer and paid supportive staff so they had the necessary tools for leading the activities, and instruction documents were produced to inform both field trip tutors and students. In this marking scores where significant as all activities had a competition component and a mark
5. Execute the activities, which in many cases demanded multiple coordination of teams
6. Debrief of the field trip including changes for future applications
7. To provide research material to this paper, after the field trip, students were surveyed in order to determine from their point of view whether the field trip's goals were accomplished (Weeden, Clare; Wolley, Janet and Lester, Jo-Anne, 2011).
8. It was also Compared grades from students that attended the field trip and the ones who didn't in the final exam.

4. GEOMATICS FIELD TRIP CHARACTERISTICS AT LOS ANDES

The field trip was designed as a competition in which a significant incentive was offered to the winning team. Students were allocated into groups of 5 people considering their performance on previous exams (a mixture of good and other students) and providing some gender equity as some activities required physical efforts. During the 3 days of the field trip there were 5 sessions of competitions.

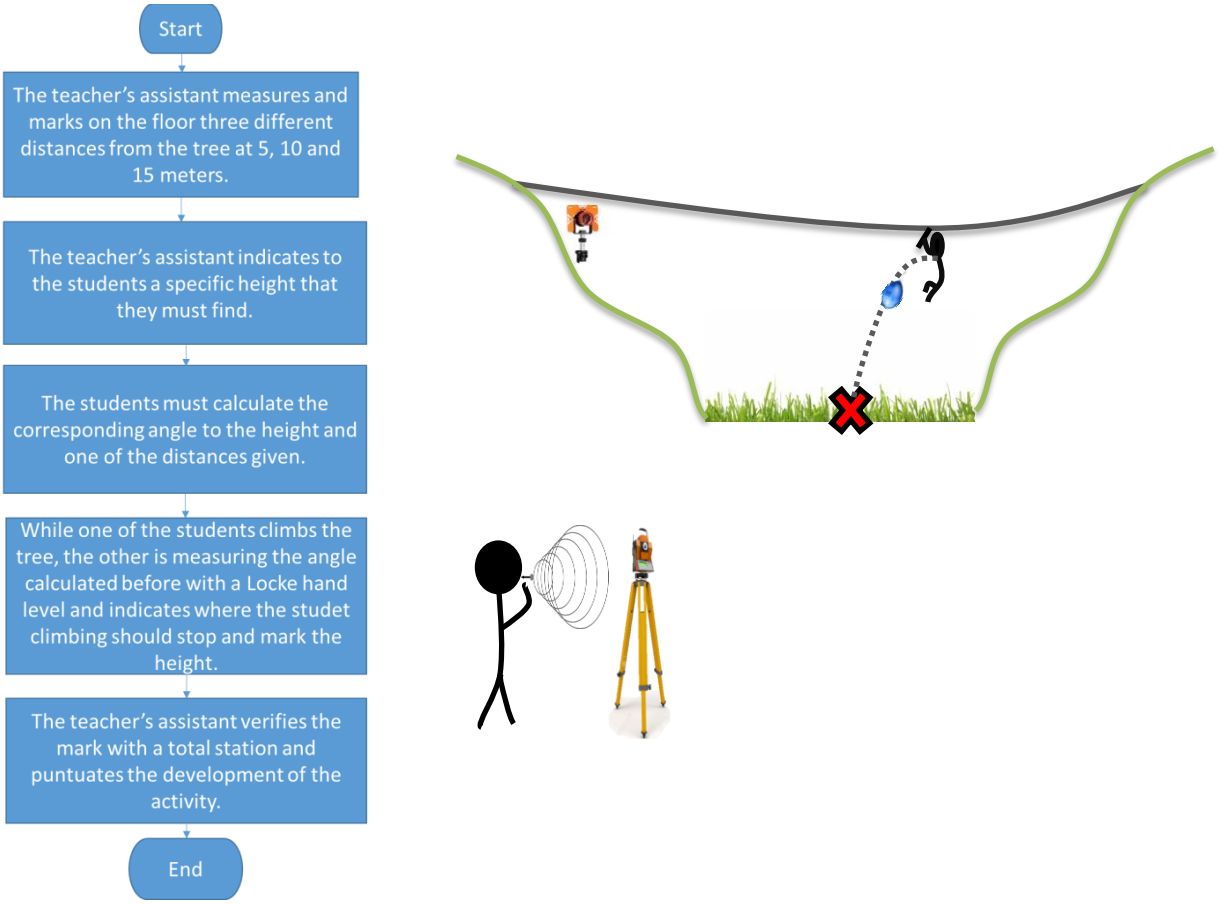
Here were 5 activities that were scored according to each team's performance and each of the 5 activities was conducted simultaneously. With this organization all teams, at different times, conducted once each of the 5 activities.

The activities not only aim to be an academic experience to deepen their knowledge in a practical way, but also as motivation and entertainment for students with the performing of physical and competitive activities.

Based on the design conducted, activities in the field trip were divided into two groups:

4.1 Complex geomatics activities

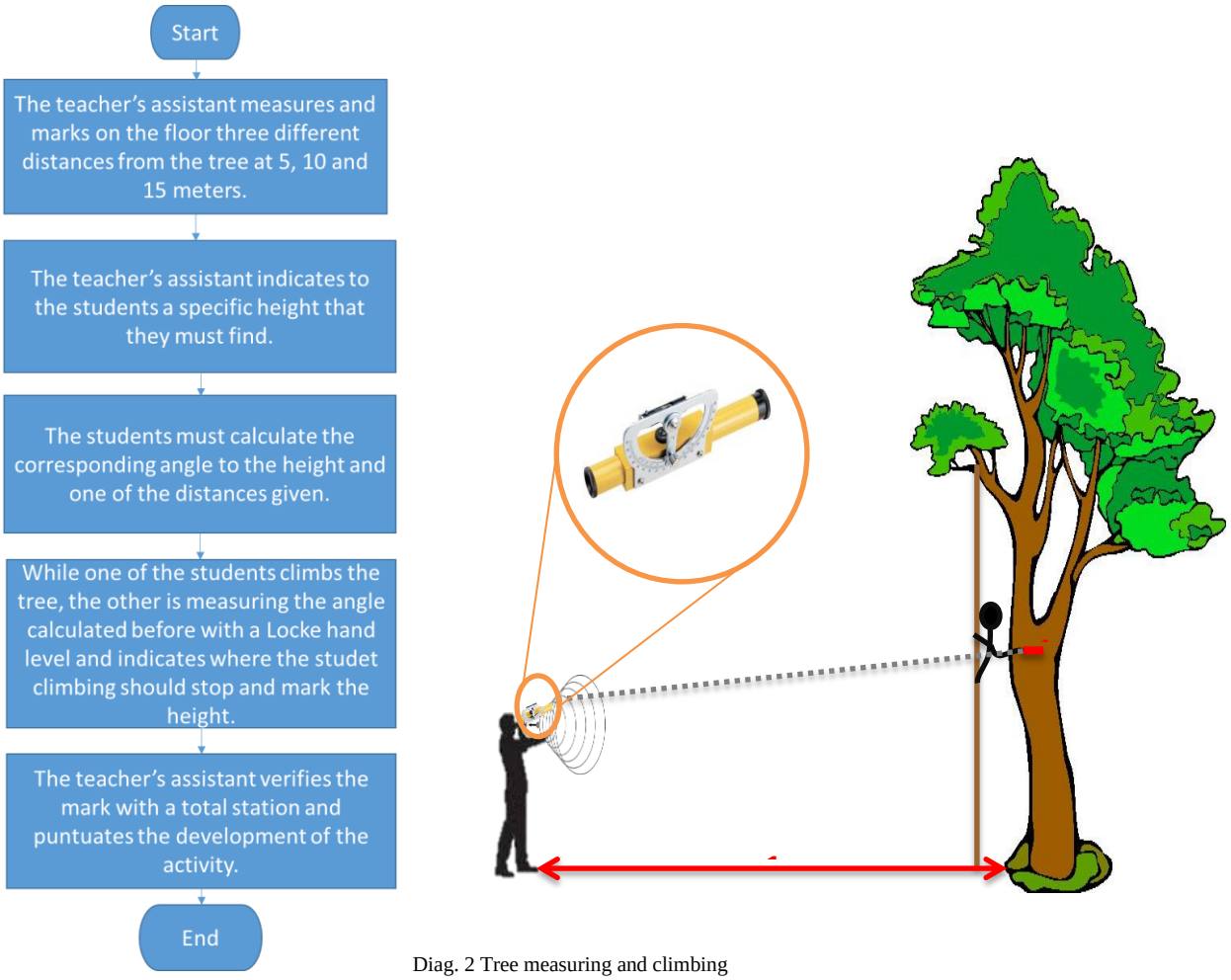
-Flying fox: In this activity, students must use the given data to calculate an angle from a known azimuth so that it intersects with the flying fox line and a team member can drop a water balloon on the specified coordinates. In this activity, students use a total station to measure an angle, which together with the data supplied, let them know the coordinates of a specific point from their knowledge into polygonal solving. The following diagram explains the activity.



Diag. 1 Flying Fox

-Tree measuring and climbing: Students must find a specific height in the tree using a locke hand level. Students may use marked distances on the ground at 5, 10 and 15 meters away from the tree and use of operations to calculate the trigonometric approximation of the

requested height, which should be indicated by a group member who climbs the tree. In this activity, students not only use their math skills, but also their physical skills as the time it took to climb the tree is a determinant factor in the score the group obtains. The following diagram explains the activity.



Diag. 2 Tree measuring and climbing

-Stakeout: Students should measure and correct a polygon with the help of a total station. The coordinates of a point on the polygon are given, as a point D after correcting the coordinates of the polygon, students must calculate the physical location of said point D, and mark the spot approximating the coordinates calculated for point D. In this activity, by using the total station, students practice how to set up and use the equipment correctly, apply what they learned on polygons based on what was taught in class, and also reinforce skills to work in group as they discuss different strategies for getting the activity done correctly and share their knowledge.

4.2 Professional and team development activities

-Race to the waterfall: Students should run in a group to a waterfall where they make measurements with tape and make a floor plan of some key points in the area. Any student

shall not be in the trail alone, there should always be at least two students together, and the group cannot start measuring until all members are present. The activity allows greater integration into the group, teaching them the importance of working together and develops better communication skills.

-Night-time Activity: Tutors (cheese) are assigned to previously marked sites, where hide. The whole group of students is divided into two teams (cats and mice) and these are subdivided into 5 or 6 subgroups. The mice are released and their mission is to find the tutors (cheese) and take them to various burrows using high precision GPS. Cats are released 5 minutes after and their mission is to recover and bring the cheese to the refrigerator using handheld GPS. The night-time activity is an entertainment activity that allows the use of technological tools for surveying in an open site and in difficult conditions. Students should know the proper functioning of GPS and create tactical groups to be winners.

-Grand final: Finally, 5 groups with the highest total scores are chosen as the finalists. Activities for the final playoff consist of a race with 3 activities that involve taking measurements in the field. The first team to reach the finish line is the winner and is exempt from the final exam of the course. The reward of winning the whole competition makes the students feel the need to perform each of the activities at their best, so that at the end of the day equilibrium of knowledge in the entire group is reached, due to the practice and effort of each student in order to win. This activity not only tests how much students have learned, but also their teamwork ability.

5. EVALUATION OF RESULTS

Once the field trip was completed and the course ended, surveys were conducted to measure the impact of the field trip on students learning. The survey was applied to 300 students, who took the course in different semesters.

To calculate the sample size the following formula was used resulting in 73 surveys. Where e = 0.1 (i.e. a maximum error of 10%) and z = 1.96 (corresponding to a level of 95% confidence).

$$n \geq \frac{p \cdot (1-p)}{\left(\frac{e}{z}\right)^2 + \frac{p \cdot (1-p)}{N}} \quad [1]$$

The results of the survey are shown in the following figures, on the scale 1 is disagree and 5 agree with the question:

[1] Probability and Statistics for Engineers and Scientists, Ronald E. Walpole, Raymond H Myers, y Sharon L. Myers. Prentice Hall, 1998.

-Contributes to my training as an engineer?

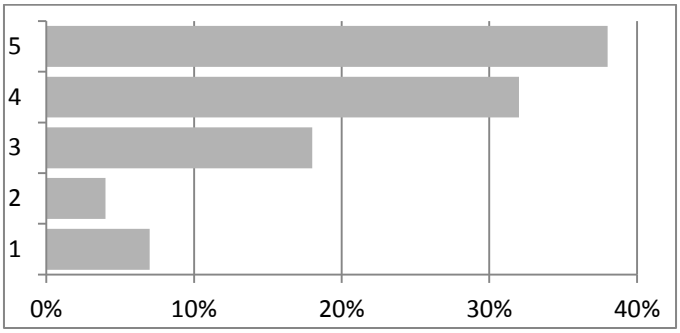


Fig. 1. Answers Question number 1

-It is an activity that facilitates geomatics learning?

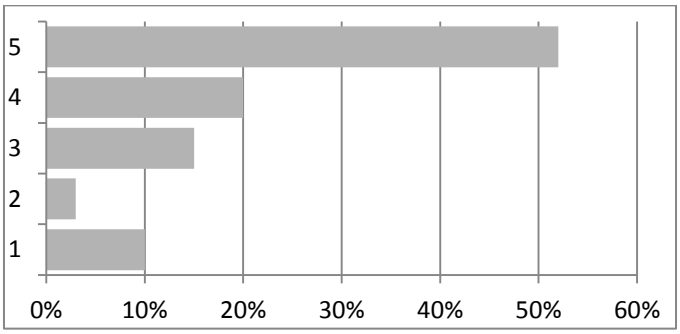


Fig. 2. Answers Question number 2

-Helps to improve my teamwork skills?

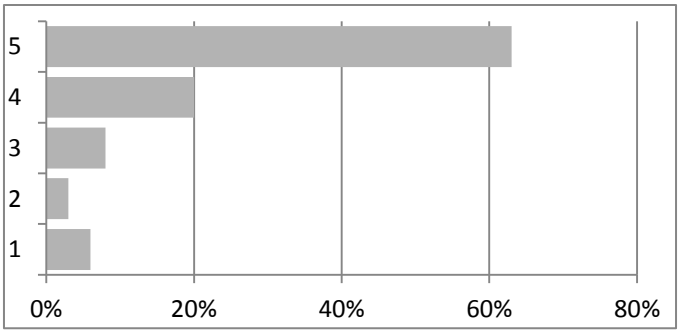


Fig. 3. Answers Question number 3

-Helps to improve my ability to solve problems?

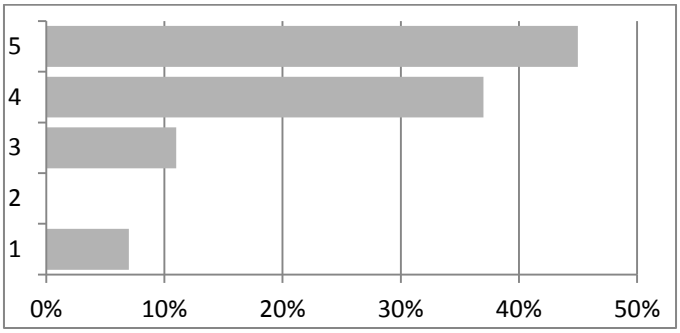


Fig. 4. Answers Question number 4

-Contributes to improve my ability handling equipment?

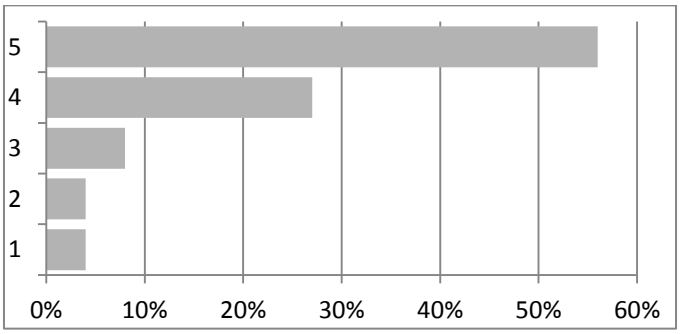


Fig. 5. Answers Question number 5

-It makes the class more formative than other classes without field trip?

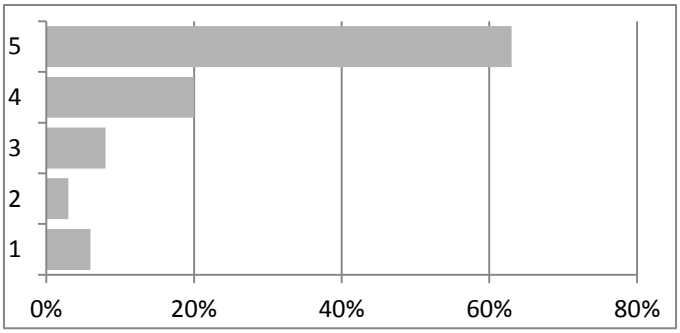


Fig. 6. Answers Question number 6

-What was your motivation to attend the field trip?

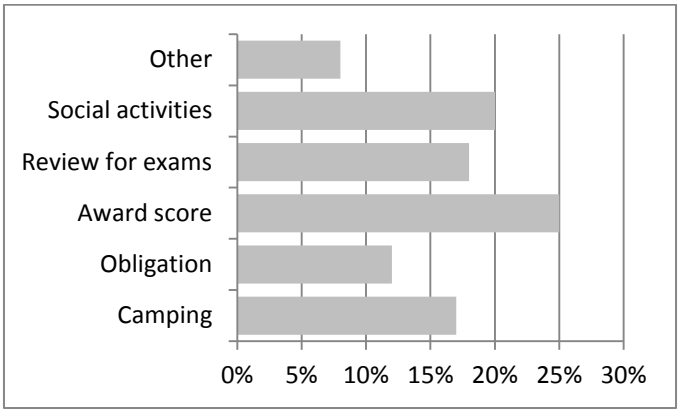


Fig. 7. Answers Question number 7

The results show for questions 1 through 6 that most students agree that the field trip helps in the formation of engineers, contributes to learning, teamwork, problem solving in geomatics and finally in their ability handling technical equipments.

Fig. 7 shows that students' motivation for attending the field trips is the award score for the final exam and social activities. However, other options provided for this question are not very far away in terms of popularity.

After taking the final exam, which has a practical part using the instruments, students claimed that the field trip helped them to prepare for this part of the exam.

Results appear to be consisted with analysis conducted to academic performance (exam results) of students. For two different semesters, it is consistent that the average scores of final exams of students who attended the field trip were 63% higher than those not attending the field trip.

The results are shown in the following table:

	2014-1		2014-2	
	Didn't attend	Attended	Didn't attend	Attended
Assembling equipment	2,67	4,50	2,40	3,76
Levelling	1,67	1,50	4,50	3,90

Table 1. Comparison between students who attended and didn't attend

The grades are presented in a scale 1-5, where 5 is the maximum grade. The final exam had two parts, in the first part students had to setup one of the topography equipment requested randomly. In the second part the student had to use a level to find the difference in height between two marked points.

It can be observed that the students who attended the field trip performed much better at setting up the equipment. This is well consisted with the objectives of the field trip as constantly setting up equipment was part of the activities.

On the other hand, in the levelling task, there wasn't such a difference between students that attended and those that did not attend the field trip. This is probably related to the fact that levelling was only a part of one activity in the field trip.

6. CONCLUSIONS

As a result of using a field trip as an activity to complement learning in a Geomatics engineering subject for undergraduate students, it was found that:

- Results from surveys conducted to students after the field trip clearly shown a wide acceptation of the activity within students. This is an encouraging results for practitioners intended to use the methodology in their learning process as a high level of acceptation is likely to provide an openness of students to learn.
- Results from this study suggest that focuses placed in the planning and development of activities in the field trip place a crucial part in the learning process of students. Based on final exam scores analysed, students that attended the fieldtrip performed better, compare to those that did not attend, when the aspect assess was a focus on the field trip. This was particularly clear for us for setting up surveying equipment as those that attend excel in the final exam compare to those that did not attend
- In contrast, but supporting the previous funding, field trip activities with low focus in the planning and development would have a nominal impact on students. Example of this was levelling. Results show that students attending the field trip did not perform better in the final exam levelling part compare to those attending.

In conclusion, and based in our experience for an undergraduate Geomatics course, this research agrees with general literature that supports the development of field trips as a valid methodology to support students´ learning process. However, results for Los Andes University show that planning and development of activities in the field trip would place a critical role in achieving learning objective.

Further research opportunities are in studying the level of resources (time an money) required to conduct a field trip compare to the benefits receive to students. Also, further research is needed to compare a standard Geomatics classroom course compare with a subject where only field trips are used.

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BIOGRAPHICAL NOTES

Daniel Paez:
Studies:
- Civil Engineer from Los Andes University in Colombia (1999)
- Specialization in SIG in Melbourne University in Australia (2001)
- Doctorate in Melbourne University in Australia (2005)

Professional Experience:
- Transport coordinator, Moreland Mayor's Office (2005-2006)
- Consultant, Booz and Company (2007-2009)
- Director of planning sustainable transport in Melbourne (2009-2010)
- Educator in Los Andes University (2012-2014)

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