On the Performance of Volunteer Students and their Engagement with Non-Volunteer Students in an Engineering Student Project

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Abstract

This work summarizes the observations derived from the participation of volunteer BSc engineering students in multi-disciplinary multi-education activity (mandatory for the rest of BSc and MSc student participants). The activity aimed at implementing a real-world sensoring use case based on advanced Internet of Things (IoT) technologies, by cooperation of students with different skills and engineering maturity levels. The work reviews the role of the volunteering students in the different phases of the project, the level of integration to the working groups, and the general learning and satisfaction outcomes. The assessment summarizes direct student input and own impressions from the project facilitator, to reflect on multiple educational training and aspects (including social and psych pedagogical perspectives) to conclude on the positive and negative aspects of this type of blended student participation.

Keywords: project-based learning; collaborative learning; multi-disciplinary education; student roles; volunteer students

1. INTRODUCTION

Multi-disciplinary projects that include both volunteer and non-volunteer students offer a rich and varied educational experience, harnessing the strengths and perspectives of a diverse group of participants (Hubbard & Gregory, 2011). These projects integrate students from different academic disciplines and different levels of engagement, fostering an environment where, typically, collaboration, innovation, and learning thrive (Holdsworth & Quinn, 2010). In general, the blend of volunteer and non-volunteer students can create a dynamic and balanced team (Tomkinson et al., 2007). Volunteer students often bring a high level of enthusiasm, passion, and commitment to the project, driven by their intrinsic motivation and desire to contribute positively. Their proactive attitude can inspire and energize non-volunteer students, who may initially participate due to curricular requirements rather than personal choice. This combination should ideally lead to a more motivated and cohesive group, as the energy and dedication of volunteers can be contagious, encouraging all members to invest more deeply in the project. However, there are other aspects such as the social attitudes, the in-group organization, or the academic pressure (Marra et al., 2016), that can put the full group development and potential at risk.

Within this context, this work describes briefly a multi-disciplinary multi-education activity carried out with both volunteer and non-volunteer engineer students (Rodriguez et al., 2023), and elaborates on the different roles, developments, and performance of the volunteer students during different phases of the activity.

1.1. A Multi-Disciplinary Multi-Education Project

The teaching project that frames the activity reported in this study is described in detail in Rodriguez et al. (2024). It considered 3 groups, each of them formed by 7 engineering students from different educations, who were expected to adopt different roles within the multi-disciplinary work. The allocations of students to each of the groups, roles, and other constrains are summarized as follows:

- 3 students from 1st year of MSc in Telecommunication Engineering (MINGTELE):
  - Expected role: group coordinators and HW/SW integrators and programmers.
  - Observations: mandatory and graded activity (non-volunteers).
- 3 students from 3rd year of BSc in Mechanical Engineering (GIMECA):
  - Expected role: Structural designers.
  - Observations: mandatory and graded activity (non-volunteers).
- 1 student from 3rd year of BSc in Telecommunication Technologies and Services Engineering (GITELE, focus group for this analysis).
  - Expected role: Network technology advisors.
  - Observations: volunteers.

As described, the balance ratio between volunteers/non-volunteer students in the groups was 1/6. This was an artifact derived from the application of official university teaching regulations which did not allow to use this activity as part of the official curriculum for the BSc in Telecommunication Technologies and Services Engineering, and therefore it was proposed to them as volunteering activity to learn about advanced technology applications and get some multi-disciplinary experience. The number of participant volunteer students was 3 out of a total set of 26 (11.5%).

The technical objective of the group work was to implement an Internet-of-Things (IoT) "Smart Object" capable of measuring temperature, humidity, and atmospheric pressure, and transmitting the information to a remote Internet server making use of wireless technology. As a reference, Figure 1 shows one of the devices built and deployed by one of the groups.

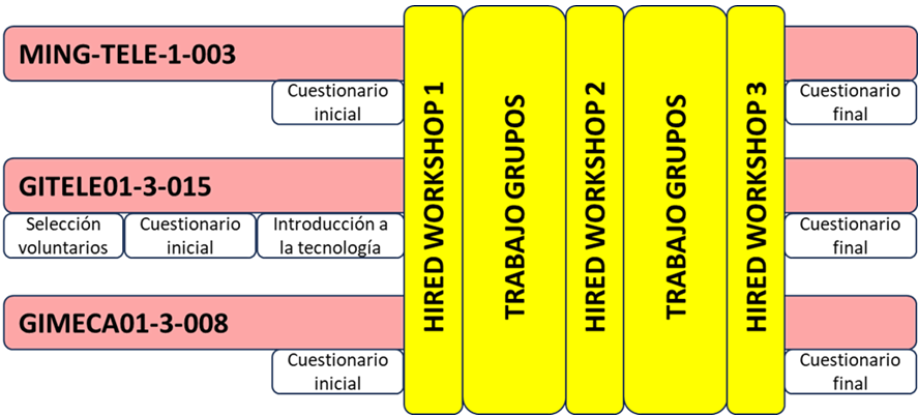
Figure 1

Pictures of one IoT Smart Object implemented and deployed by the students.

To build the device, the main teaching methodologies applied were unsupervised project work and supervised workshop sessions. The students were instructed to organize by themselves and work autonomously. The main objective was to emulate a cooperative work environment where the students could socialize and put into practice their expert technical skills and develop their multi-disciplinary competences. The workflow of the activity is detailed in Figure 2. The workshop sessions served mainly as progress monitoring and evaluation checkpoints (except the first one, where the activity was introduced, the groups were formed, and socialization exercises were proposed to trigger the group work). As indicated, the group of volunteer students from GITELE participated in one extra work session as compared to their non-volunteer peers. As volunteer students were assigned the role of network advisors, they got a brief introduction to the IoT communication technology that was put in practice, increasing their knowledge and expertise in the area prior to the beginning of the group work.

Figure 2

Planned workflow for the resulting teaching activity, including unsupervised group work ("trabajo grupos") and supervised sessions ("workshops": W1, W2 and W3); as well as other specific teaching sessions (introduction to the technology: "introduccion a la tecnologia") and evaluation activities (questionnaires: "cuestionario inicial/final"). From (Rodriguez, 2024).



2. METHODOLOGY

The assessment of the performance of the volunteer engineering students presented in this paper is based on:

- Online anonymous questionaries: two questionaries (one initial: collected prior to the beginning of the unsupervised group work; and one final: collected at the last supervised workshop) were used to compile the opinions and perception of the students. The questionaries asked about the education of the students, which allowed us to filter the results from volunteers and non-volunteers.
- Direct feedback between volunteer students and activity facilitators: unplanned informal face-to-face conversations happened during the activity. The topics addressed spanned indistinctly between the general status of the group work, the overall satisfaction, or specific technical needs. The main aspects were logged in by the facilitators for self-reference.
- Observations from the supervised sessions: at these sessions, all blended groups with volunteer and non-volunteer students, as well as project facilitators were present. This allowed the project facilitators not only to monitor the group work status and provide feedback, but to compare the group performance and evaluate the relationships between volunteer and non-volunteer students. Relevant observations were logged in by the project facilitators.

3. RESULTS

The combination of the outcomes from the different questionaries, the direct feedback, and the observations from the supervised sessions, were analyzed and summarized, producing results with focus on different training and educational management aspects.

3.1. Evolution of the Role of Volunteer Students during the Project

As initial reference, the volunteer students had no previous experience in project-based learning (PBL) activities, all of them prefer practical work over theory, and 66.6% were not sure whether they were prepared to face the multi-disciplinary activity.

Table 1 summarizes key aspects of the project development as well as the perceived role of the volunteer students at the different stages. Roles were classified as per (Jhonston, 2005). A clear evolution was observed in the complex relationships between volunteers and non-volunteers. During the two initial stages (phase 0 and phase 1) an enthusiastic phase is experienced. Initially, the volunteers are the ones mastering the technology to be used within the technical implementation, and they take a central role in the groups, feeling valued by the non-volunteer peers. As part of the multi-disciplinary interaction, the technical knowledge was transferred to the group peers, which made that, gradually towards the end of the project (phase 2), volunteers are pushed into secondary roles by the non-volunteer group members. This was experienced by the volunteers in all three groups, which were "left apart" from the final developments in the last days prior to the last workshop. It was the belief from the non-volunteer students that volunteer students would not contribute at the same level since they did not have the pressure of the final evaluation and grading process.

Table 1

Summary of key project aspects evolution with focus on volunteer student roles and performance.

	Phase 0 (prior to W1)	Phase 1 (W1-W2)	Phase 2 (W2-W3)
Group developments	No groups yet. Volunteers are trained in the technology that will be used.	Groups in operation. Focus on socialization, organizational aspects, and multi-disciplinary interactions.	Groups working towards final product implementation and final presentation. Non-volunteers pressured by final hand in deadline. Volunteers were "left apart" from the regular group work.
Volunteer performance	Non-experts but highly-motivated. Correct acquisition of technical competences.	Leadership in technical discussions (not in organizational). Structured technical knowledge transfer to non-volunteers.	Secondary actors, on-demand participation.
Role of the volunteers	Ready Learner	Coachees, Contributors, and (Active) Team Members	(Passive) Team Members

Although this was not a desirable outcome, from a learning perspective, it can be seen as both a success and a failure. It can be considered a success as the technical knowledge mastered by the volunteers was fully transferred to the non-volunteers. If this had been the case, the volunteers would have never been left apart. However, it can also be seen as a failure when considering all other non-technical soft skills such as socialization, or group collaboration.

3.2. Generalized Learning and Satisfaction Outcomes

Despite the issues, volunteer students believe that the activity was useful and representative of future professional situations. A few more details are given in the following.

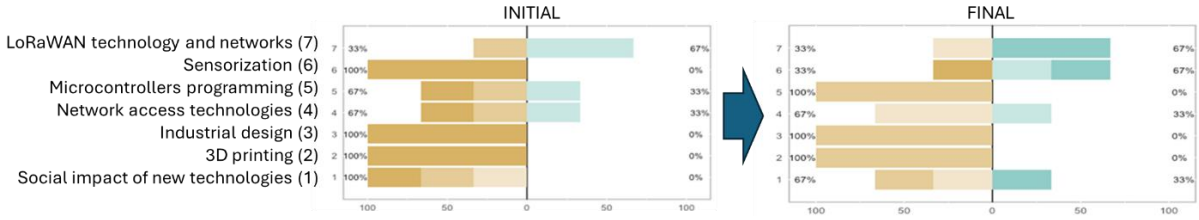
3.2.1. Learning Outcomes (Knowledge Evolution)

Figure 3 depicts the learning perception experience by the volunteer students in the multiple technical areas of the project. It should be noted that we discuss learning perception and not actual

technical knowledge level as the students were asked for their impression but were not actually tested in technical details. In this respect, the volunteer students, from GITELE, expressed that, after the activity, they believe that they had increased notably their knowledge in those areas of expertise directly related to their main field of study (communications). However, they also expressed the opposite for those multi-disciplinary topics outside their main expertise (mechanics).

Figure 3

Evolution of the technical knowledge perception by the volunteer students for the different topic areas addressed by the multi-disciplinary project. Question: "Rate from 0 (-100) to 5(+100) your knowledge in the different project topics/areas."

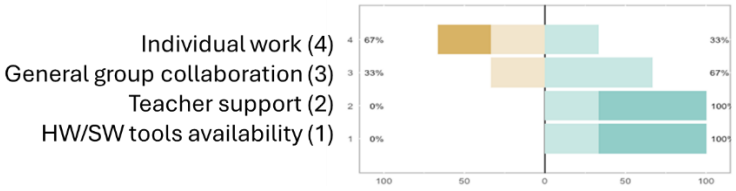


3.2.2. Final Satisfaction Levels

In terms of satisfaction, as summarized in Figure 4, volunteer students were generally content with all the different teaching components. Interestingly, while the opinion on group collaboration was neutral, volunteer students were quite critique about their own work, as they have the perception that they could have done something else to avoid the final collaboration issues with the non-volunteer students.

Figure 4

Satisfaction of the volunteer students with the different teaching components of the activity. Question: "Rate from 0 (-100) to 5(+100) your level of satisfaction with the following aspects related to the project."



3.3. Project Facilitator Views

Several useful observations can be done also from the teacher/facilitator point of view, which can help understanding the overall outcomes of the activity and the global level engagement of volunteer and non-volunteers within the groups:

- The volunteers were average-top students: this sets some high-level baseline standards on the expected engagement and quality of the work to be contributed by the volunteers.
- The volunteers were very active during the initial technology introduction session: they asked many questions until they were sure to fully understand the technical challenges that they were going to address during the group work as well as the potentially applicable network communication solution. This behavior is quite related to the one described in the previous observation.
- During the project, the volunteers called for short informal face-to-face checkup meetings with the facilitator during the project: they had no big questions or concerns, only minor

questions about practical networking aspects were discussed. The students sought to strengthen their knowledge prior to transferring it to their non-volunteer peers.

- The volunteers fulfilled the tasks according to their role within the groups: as all implementations were functional and deployed at valid locations.
- The volunteers did not share their group experiences/problems until the project was finished: despite having been "left apart" from their groups in the last stage, the volunteers did not report this fact to the facilitators. This can be explained from a social interaction point of view to maintain a good atmosphere towards their peers, knowing that already their main part of the work was completed.

4. DISCUSSION

By analyzing the different educational training aspects, volunteer students showcased limited learning outcomes in areas of expertise outside the main ones from their main education. This can be explained by the social interaction within the groups which was slightly degraded towards the end of the activity when most of the technical multi-disciplinary exchange is expected to happen. From a psych-pedagogical perspective, it is advised to apply increased planning and monitoring of the activity and the evolution of the volunteers within the groups. For this, continuous feedback is also suggested to limit the potential experienced frustration and guarantee a correct level of volunteer student integration throughout the full cycle of the activity.

Based on the presented observations, it is possible to highlight positive and negative aspects of this type of blended student learning for volunteer students:

- Positive aspects: volunteer students participated throughout the entire activity and completed their tasks as much as they could.
- Negative aspects: volunteers did not acquire knowledge outside their own one and were shy to report the problems with non-volunteer students.

A main recommendation is proposed for improvement in potential future editions of the activity, which is to share the reported learnings with volunteers and non-volunteers prior to next activities. Making a proper introduction of the different roles, importance, and evolution within the groups is expected to motivate a positive attitude towards full extent collaboration between volunteer and non-volunteer students.

5. CONCLUSIONS

Based on the analysis of the performance of volunteer students and their engagement with non-volunteer students in a multi-disciplinary multi-education group activity, it was observed that volunteer students went through an evolution. Their roles evolve from ready learners to contributors and active team members; finally reaching a state of passive team members, because of the interaction with the non-volunteer students. The specialized knowledge transfer from volunteers to non-volunteers was successful and all groups succeeded in achieving the technical project objectives. However, the knowledge transfer from non-volunteer towards volunteers was limited, due to the more social developments in the final stages of the activity. Issues were identified, and recommendations were proposed to apply in future editions of the activity.

ACKNOWLEDGEMENT

This work was supported by the Spanish Ministry of Science and Innovation under Ramon y Cajal Fellowship number RYC2020-030676-I, funded by MCIN/AEI /10.13039/501100011033 and by the European Social Fund "Investing in your future".

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