"Should I become a computer engineer?" Using an immersive experience with upper secondary students to support faculty choice

"Dovrei fare l'ingegnere informatico?" Usare un'esperienza immersiva con studenti della scuola secondaria superiore per promuovere l'orientamento universitario

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HOW TO CITE Tacchella, A., Oreggia, M., Passarelli, M., Pozzi, F., & Chiorri, C. (2022). "Should I become a computer engineer?" Using an immersive experience with upper secondary students to support faculty choice. *Italian Journal of Educational Technology, 30*(2), 97-110. doi: 10.17471/2499-4324/1272

ABSTRACT Universities often carry out initiatives to assist upper secondary students in their choice of university faculties and courses. However, most of such initiatives are transmissive, and do not offer students hands-on experiences or opportunities for peer interaction. This paper instead presents an immersive, team-based experience on educational robotics offered to prospective students in Computer Engineering (N=88). Evaluation of the activity focused on: (1) improvements in students' awareness when it comes to pick a faculty and a course; (2) improvements in basic Computer Sciences knowledge; (3) prospective students' interactions and community-building. The results suggest that students' knowledge and skills are improved at the end of the experience and that this has a positive effect on their attitude towards the choice of a specific faculty and/or course. Student interactions proved to be more critical, as most teams displayed a low quality of social interactions.

KEYWORDS Course Choice Guidance; Post-Secondary Education; Educational Robotics; Collaborative Learning; Immersive Approach.

SOMMARIO Le università propongono frequentemente iniziative per supportare la scelta del corso di laurea da parte degli studenti di scuola superiore. La maggior parte di tali iniziative, tuttavia, hanno un approccio trasmissivo e non offrono agli studenti attività pratiche o opportunità per interazioni tra pari. Questo articolo propone invece un'attività collaborativa e immersiva che usa la robotica educativa. L'attività è stata proposta a degli studenti interessati ad iscriversi a ingegneria informatica (N=88). La valutazione dell'attività ha preso in considerazione: (1) l'aumento della consapevolezza da parte degli studenti nella scelta di un corso di studi; (2) il miglioramento nelle conoscenze informatiche di base; (3) le interazioni e la costruzione di comunità tra i potenziali studenti. I risultati suggeriscono che al termine dell'esperienza la conoscenza e le capacità degli studenti siano migliorate e che questo abbia avuto un effetto positivo sul loro atteggiamento verso la scelta di un corso di studi. L'interazione tra gli studenti è risultata essere più critica, in quanto la maggior parte dei gruppi ha presentato una bassa qualità delle interazioni.

PAROLE CHIAVE Orientamento Universitario; Formazione Universitaria; Robotica Educativa; Apprendimento Collaborativo; Approccio Immersivo.

1. INTRODUCTION

Success in higher education is crucial for jobs, productivity, and growth. For this reason, the European Union (EU)'s strategy in Europe 2020 program includes the target of 40% of young people completing higher education by 2020 (Quinn, 2013). The same report notes that "*too many students in the EU drop out before they complete their higher education degree*" (Quinn, 2013, p. 9) and therefore suggests "preparing students for higher education" and "*supporting transition into higher education*" (Quinn, 2013, p. 59).
Romito et al. (2020) have recently highlighted how drop out in higher education is a longitudinal process of interactions between the student and the social and academic system of tertiary education, which is impacted by the students' initial expectations regarding the study programme they choose.
In this light, the first contact between higher education institutions and prospective students appears of crucial importance (Pordelan, Sadeghi, Abedi, & Kaedi, 2018).
Looking at what it is currently offered in terms of course choice guidance by most European universities, we can see there are several online services, typically organized by consortia of higher education institutions, which provide online information and guidance across universities. There are also residential exhibits (also referred to as "*orientation fairs*"), where students can find information, have a direct contact with the institutions, ask for information, and so on. Furthermore, single universities organize one-shot informative events and open initiatives to inform and possibly attract students.
Despite such variety, it should be acknowledged that all these initiatives tend to take the form of "information-oriented services", rather than "immersive", hands-on approaches. Moreover, regarding orientation fairs, some authors have underlined these events tend to become rather "*market devices, i.e. a discursive and praxiological tool by which higher education markets sustain their existence*" (De Feo & Pitzalis, 2018).

All these 'transmissive' and market-oriented approaches that usually underpin the proposed guidance interventions are likely to fail to provide students with a direct, immersive, and situated experience, thus running the risk of creating misleading expectations and making the prospective student a passive actor in the course choice process, and – ultimately – raising the risk of future drop out.
Building on these premises, we wanted to study possible alternative solutions in terms of 'guidance services' and to understand whether and to what extent these can help students taking more informed decisions. In particular, our initial hypothesis was that adequately introducing upper secondary students to the courses offered by post-secondary educational institutions and offering them with the opportunity to live a simulated 'typical faculty week' could help students test their skills and inclinations in an evaluation-free environment, to gain some basic disciplinary knowledge on subjects that may have not been part of their secondary school curriculum, and lastly to lay the basis of community building for future students, thus helping them

make more informed decisions.

To do so, the University of Genoa has tested an innovative guidance service, oriented to provide upper secondary students with the opportunity to experience the courses offered directly. The pilot study for Computer Engineering is conceived as a weeklong immersive experience, where students attend regular lectures, visit laboratories, and are offered practical and peer-programming sessions based on educational robotics. The aim is to introduce students to the basics of the main disciplines at the core of Computer Engineering and provide them with the opportunity to test and train their skills and inclinations.

This paper illustrates the experience from three specific perspectives, each focusing on a way in which immersive experiences can offer an advantage over transmissive approaches: course choice, knowledge building, and social interactions. Each perspective therefore examines a specific research question:

- (RQ1) Can an immersive experience of a simulated "typical faculty week" support upper secondary students in their faculty and course choice?
- (RQ2) Can an immersive activity based on educational robotics provide upper secondary students with some basics of Computer Engineering?
- (RQ3) Can peer programming approaches promote community-building and positive student interactions?

After presenting the theoretical rationale for focusing on these three angles, we describe the methods and procedures adopted in the study and then we report the results of the pilot study.

1.1. *Background for Immersive and situated experience as a strategy to support faculty and course choice*

Situated learning approaches focus on the importance of the cultural and social context where learning takes place, since this context is strictly intertwined with the knowledge development process (Brown, Collins, & Duguid, 1989). According to these approaches, the educational experience has to be as much authentic and genuine as possible, so that learners can experience, observe and critically reflect on real situations (Lave & Wenger, 1990).

Somehow surprisingly, we were not able to find any relevant example of course choice guidance based on immersive and situated approaches. This denotes a gap in an area where it is particularly important that the prospective undergraduate student – who is seeking to understand if the course and faculty at hand are the 'right ones' – 'learns in context', i.e. makes a preliminary, direct experience of what her/his future learning – and possibly working –environment will be. This might help students in "testing" their preliminary, and often naive, beliefs and expectations about the course and the future profession. Moreover, students often tend to overestimate their academic capabilities (Pajares, 1996) and can be "unskilled-and-unaware" of their abilities (for a recent review, see, e.g., Serra & DeMaree, 2016) and this can impair their study behaviors (Metcalfe & Finn, 2008). In order to fill in this gap, in the present paper we suggest alternative solutions for guiding upper secondary students' University course choice through the adoption of immersive and situated approaches.

1.2. *Background for the adoption of educational robotics to introduce some basics of computer engineering*

Given that programming is a demanding task involving a complex set of competences, abilities, and skills, it is often considered by novices as dull (Kelleher & Pausch, 2007; Major, Kyriacou, & Brereton, 2012). Sometimes, if the required initial effort is too high, this may lead to high course withdrawal rates or poor academic performance (Kinnunen & Malmi, 2006). Consequently, alternative solutions to programming education have been explored in the last decades (Kelleher & Pausch, 2005) and one of the resulting solutions is the use of robotics to support Computer Engineering and Computer Science teaching/learning processes. Such solution stems from the tradition of constructivism (Turkle & Papert, 1992) and has then become quite popular, also because of the availability of relatively cheap robot kits that allow teachers to propose hands-on activities and introduce novices to a variety of disciplines, including electrical engineering, mechanical engineering, and computer science (Yu et al., 2001). Robots are highly motivating and exciting for students (Sklar, Eguchi, & Johnson, 2003), they appeal to a variety of people of different ages and backgrounds (Hirst, Johnson, Petre, Price, & Richards, 2003), and may also lead to unintended learning (Ioannou & Makridou, 2018; Petre & Price, 2004). Many experiences have been carried out in the field of STEM education (e.g., Chambers & Carbonaro, 2003; Kumar & Meeden, 1998; Nugent, Barker, Grandgenett, & Adamchuk, 2010), and much effort has been devoted to investigate the use of physical robotic tools focusing on LEGO® Mindstorm® robots (Major, Kyriacou, & Brereton, 2012).

Despite some concerns raised about the actual effectiveness of robots in teaching Computer Science in laboratory sessions (Fagin & Merkle, 2003), including possible cognitive overload (Yu et al., 2001; Gaines & Balac, 2000), there is a general tendency to consider such approach as promising (Major et al., 2012).

In the reported experience it was decided that, in order to introduce some basics of Computer Engineering, LEGO® Mindstorm® robots could be used as an approach for undergraduate students who were about to take on the complex task of programming for the first time. This type of activity represents the two main foci of the University course (i.e. programming and automation), so it can be considered to be a faithful representation of the environment students would find in the actual university course, while still being highly engaging and motivating. Additionally, the robots used are relatively inexpensive, so the activity could be replicated by another Higher Education institution with relatively low expense.

1.3. *Background for collaboration and pair-programming strategies to promote positive social interactions and community building*

Socio-constructivist approaches to learning emphasize negotiation as the basic element in the process of constructing new knowledge, and consider language, dialogue, and collaboration as the main learning tools (Salomon 1997; Vygotskiĭ, Hanfmann, & Vakar, 2012). Consequently, traditional teaching methods, which are basically transmissive in nature, have started being replaced and/or integrated with more collaborative learning approaches (Kanuka & Anderson, 1999). Co-learning and co-working approaches have increasingly been permeating many fields, and pair-programming (or pair-coding) has started to attract attention as a possible solution to improve software development strategies (Cockburn & Williams, 2000). Furthermore, peer support may prove crucial for student retention during the early years of a University course (Robinson, Le Riche, & Jacklin, 2007), and promoting student interaction in an early phase may help community building.

In the experience reported in this paper, collaboration among peers has been proposed not only for its benefits on learning, but also because students can make a direct experience of these new approaches to software development. Furthermore, a collaborative experience can promote positive interactions between students and lay the foundation for community building and future peer support between the students who choose to enrol.

2. METHOD

2.1. *Context and participants*

the experience focused on students from the fourth and the fifth year of upper secondary schools (12th-13th grade), which in Italy correspond to seventeen and eighteen-year-old students, respectively. Students were from preparatory ("liceo") and vocational ("istituto tecnico") upper secondary schools.

The course "Ingegneria Informatica" (Computer Engineering) at the University of Genoa held an educational guidance experience for upper secondary students in two cohorts. A total of 88 students were enrolled in the two years, 49 from grade 12 and 39 from grade 13. Eight of them were girls, and 80 were boys. The students came from 12 different upper secondary schools, 77 students from "liceo" and 11 from "istituto tecnico".

Participation was voluntary, both at the school and student level, so the sample may be considered biased to include a higher-than-average interest in computer engineering, and a higher-than-normal intention to enrol in the Computer Engineering course. Voluntary participation may also be one of the reasons for the high gender imbalance.

2.2. *Procedure*

Each student attended a total of 30 hours of activities in one week (6 hours per day).

Activities consisted of 2 hours of test administration, 6 hours of University lectures, a two-hour meeting with "Manager Didattico" focusing on course choices (in which students could ask questions about the University courses), and 20 hours of peer programming lab experience.

At the end of the activities, students were expected to have acquired basic computer programming skills to program LEGO® Mindstorms® robots to accomplish basic tasks and to compete in a group-based tournament. The choice to propose a final tournament among groups was based on the rationale that team-based competition is highly motivating for students, fostering internal cohesion within groups and engaging students, while avoiding the excessive stress of individual competition (Passarelli et al., 2019).

During the peer programming lab experience, students were divided in groups of 2-3 students each. The programming experience entailed both instruction provision regarding how to use the visual programming environment, and actual group coding of the robots' behaviour. Students were supervised and supported by a teacher, a researcher, and a few tutors (in the role of observers).

2.2.1. *Robot programming*

Robot programming was carried out with the LEGO® Mindstorm® NXT2.0 series kit, which contains software and hardware to create customizable, programmable robots. Six computers running MS Windows operating system were used for visual code development and cross-compiling. In order to perform the data collection, students had to complete a questionnaire (as described in 2.3.1). Students could connect to the server through a private network by using a Samsung Tab 3® provided by the University. Each student had his/her own pre-generated account to keep track of the personal data and to match the pre- and the post-test data.

All the robots were built before the start of the experience and the students could not modify them. The robots had two motors to move through the field, one motor to use the gripper to grab the ball and four sensors: InfraRed Seeker, Compass, Ultrasonic, and Color. The students knew that their robot would have to participate to a tournament and play football against the robots of the other groups in one-to-one matches. During matches, the robot had to try and kick an infrared-emitting ball in the opponent's goal, similarly to the games of the World Robot Olympiad (WRO) Gen II Football Contest[1].

Robots played in a rectangular field (122 cm x 183 cm), bounded by a yellow area that was a 30-degree inclined plane to prevent the ball from falling outside the field or remaining stuck in a corner. The field had two goal zones (45 cm x 45 cm) painted black and oriented eastward and westward respectively, a central

[1] See for example: https://www.wro2016india.org/wp-content/uploads/2016/01/WRO-Football-Rules_14.01.16.pdf

zone (45 cm x 93 cm) painted in white, two lateral zones (38.5 cm x 183 cm) painted red (the northern one) and green (the southern one).

The tournament consisted of a round robin tournament followed by knockout matches. The robots played matches according to how they were programmed, without human control. Students could develop different strategies (one different program for each strategy), and they could switch strategy each time the action was stopped. Robots needed to catch the ball and throw it in the goal. The final ranking of the tournament was recorded each week.

2.3. *Measures*

In order to evaluate the overall experience and collect data to address the research questions, we used a mixed approach. In particular, to cover (RQ1) and (RQ2) we collected data about the students' profiles, their previous knowledge, and their analysis and synthesis abilities through questionnaires (before and after the experience). To monitor groups' behaviour during peer programming (RQ3), we used an observation grid filled in by observers.

As mentioned in the Introduction, we decided to focus on three specific angles, i.e. intention to choose a specific course, knowledge building, and social interaction.

In order to explore the experience from each of these angles, high level indicators were defined, which were then tested against the data coming from questionnaires and the observation grid. In particular, we expected that:

- (RQ1): Can an immersive experience of a simulated "typical university week" support upper secondary students in their faculty and course choice?
  - (Indicator 1.1): changes in students' intentions regarding their choice after the immersive experience;
  - (Indicator 1.2): intention to choose reported by the previously undecided students after the immersive experience.
- (RQ2): Can an immersive activity based on educational robotics provide upper secondary students with some basics of Computer Engineering?
  - (Indicator 2.1): impact of the proposed activity on students' knowledge;
  - (Indicator 2.2): impact of the proposed activity on students' ability to solve analysis problems;
  - (Indicator 2.3): impact of the proposed activity on students' ability to solve synthesis problems.
- Can peer programming approaches promote community-building and positive student interactions?
  - (Indicator 3.1): impact of peer programming on groups' cognitive presence;
  - (Indicator 3.2): impact of peer programming on groups' social presence;
  - (Indicator 3.3): impact of peer programming on groups' teaching presence.

Importantly, the aim of the activity was supporting course choice, and not persuading students to enrol in Computer Engineering, specifically. Accordingly, the indicators consider students' reduction in uncertainty regarding "intention to enrol": if a student report uncertainty regarding their course choice before the activity, and a clear intention afterwards, this is considered a good outcome even if the intention is to not enrol in Computer Engineering.

2.3.1. Questionnaires

Questionnaires were administered through Limesurvey[2]. Data were collected at the beginning (pre-test) and end (post-test) of the experience.

The pre-test was completed before the beginning of the experience, during the first day. It was divided into 6 parts:

[2] www.limesurvey.org

- Profile. Personal data as name, surname, class, school, gender, average time of daily computer use (from 1 = less than half an hour, to 4 = more than 2 hours);
- Experience: questions about how students used computers and whether they used them for programming;
- Attitudes. Questions about students' perceived level of academic achievement (from 1 = excellent to 4 = barely passing), their favourite subject at school (Humanities, Science, Technical subjects, Language or Arts), whether they were planning to enrol in a course at the Polytechnic School (yes, maybe, no) and in the course "Ingegneria Informatica" (yes, maybe, no);
- Knowledge (10 items). Questions about the course and the job as "Ingegnere Informatico" (Computer Engineer), questions about software concepts;
- Analysis (9 items). Students had to analyse the behaviour of algorithms given as flow charts;
- Synthesis (2 items). Students had to design their own flow charts to solve two given problems.

In the last three sections the students were instructed to answer only the questions they were able to solve, without guessing. Accordingly, the score for every answer was: +1 for each right answer, 0 for each blank answer and -1 for each wrong answer.
In the post-test students were administered the Knowledge, Analysis, and Synthesis sections (with different but equally difficult items); this happened before the tournament took place.

2.3.2. *Observation grid*

During the immersive week, students were helped and monitored by a researcher and three tutors. Monitoring focused on the behaviour of students, observing their interactions, community building behaviours and collaborative work patterns within each group. The observers collected information about the ability of the groups to develop cognitive presence, social presence and teaching presence among peers (Garrison, Anderson, & Archer, 2001). For each group and for each activity (learning, development), a grid was used which was divided into three sections:

- Cognitive presence: "the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry" (Garrison et al., 2001). In particular, the main features were the ability, as a group, to separate and to deal with the theoretical and the practical approaches (it was essential to separate the design, implementation, and testing part for both the first and the second activity). As result of this monitoring, a "high" or "low" label was used to mark each group.
- Social presence: as defined by Rourke, Anderson, Garrison, & Archer (2001), this is the ability of participants to project themselves socially and emotionally in a community, as "real" people (i.e., their full personality), through the medium of communication being used (Garrison, et al., 2001). As for the Cognitive presence, a "high" or "low" label was used to mark each group.
- Teaching presence: "the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes" (Anderson, Rourke, Garrison & Archer, 2001, p. 5). In particular, the emergence of leading roles was monitored, as well as the strategies used by groups to manage time (i.e. how the students managed the preparation of the robot with respect to the design, implementation and verification in the field). Students were rated as "high" if the work was organized in a manner sufficient to complete the task in a conscious way as opposed to a fortuitous way, "low" if the students were not able to organize themselves in order to finish the task, or to fix errors without relying on haphazard trials.

After the challenge, the labels of the three sections are compared with the ranking position that the groups achieved during the final tournament.

3. RESULTS

3.1. *(RQ1): Course choice*

Statistical analyses were performed using R software (R Core Team, 2014) with lme4 (Bates, Maechler, Bolker, & Walker, 2014), lmerTest (Kutznetsova, Brockhoff, & Christensen, 2014) and LMERConvenienceFunctions (Tremblay & Ransijn, 2014) packages.

As expected by the convenience sample, the percentage of students that reported having intention *not* to enrol in the polytechnic school or in the Computer Engineering program was very low (8% and 2%, respectively). However, the percentage of students that reported being undecided before the activity was quite high (58% and 78% for the polytechnic school and the Computer Engineering program). The percentages of undecided students were lower after the experience (44% and 51%, respectively). The change in the intention to enrol in the Polytechnic School and in the Computer Engineering program was tested using a modified Quasi-Perfect Mobility Model (QPMM, Goodman, 1979; Van Leeuwen & Maas, 1991), which is a special case of the Independence Model (IM) in loglinear analysis. In our case, this model predicts that intentions before and after the experience are independent. However, it could be assumed that most students will likely stick to their initial intention, and only a minority of them will change their mind after the experience. In other words, it would be reasonable to assume that the frequencies in the diagonal cell (i.e., the no-change cells) will be overrepresented, as appears to be the case of Table 1 and Table 2. The QPMM adds extra parameters for the diagonal cells and generates expected frequencies of the diagonal cells that match exactly the observed ones, since it specifies a separate parameter for each of these cells. In the estimation of the relative positions of intentions, it can also be assumed that intentions with much exchange between them are close to each other (e.g. “yes” and “undecided”), whereas intentions with little exchange are far apart (e.g, “yes” and “no”). We thus added extra- parameters to account for this effect.

INTENTION TO ENROLL IN THE POLYTECHNIC SCHOOL BEFORE THE EXPERIENCE	INTENTION TO ENROLL IN THE POLYTECHNIC SCHOOL AFTER THE EXPERIENCE		
	Yes	**Maybe**	**No**
Yes	22	3	0
Maybe	19	32	5
No	1	4	2

Table 1. Intention to enroll at the Polytechnic School before and after the experience.

INTENTION TO ENROLL IN THE COMPUTER ENGINEERING PROGRAMME BEFORE THE EXPERIENCE	INTENTION TO ENROLL IN THE COMPUTER ENGINEERING PROGRAMME AFTER THE EXPERIENCE		
	Yes	**Maybe**	**No**
Yes	17	0	0
Maybe	14	45	10
No	0	0	2

Table 2. Intention to enroll in the Computer Engineering programme before and after the experience.

Since in the QPMM frequencies of the diagonal cells have to be exactly reproduced, significant differences can only pertain to off-diagonal elements, i.e., cells representing change. The independence model had to be rejected in either case (intention to enrol at the Polytechnic School: $L^2(4) = 18.71$, $p = .001$; intention to enrol in the Computer Engineering program: $L^2(4) = 13.93$, $p = .007$). The inspection of cell adjusted standardized residuals (ASRs) revealed that, after a Bonferroni-Holm correction of the p-value for multiple comparisons, in either case the observed frequency of students that changed from “Maybe” to “Yes” was significantly higher than the expected frequency under the null hypothesis of no change ($z = 4.67$, *adj-p* < .001 and $z = 2.40$, *adj-p* = .032, respectively). In the model for the intention to enrol in the Computer Engineering program we also observed a significantly lower observed frequency for students that switched from “*Yes*” to “*Maybe*” ($z = 2.40$, *adj-p* = .003).

We also considered that data came from 2 different cohorts. Additional analyses showed that this variable had no effect, either direct or in interaction with the others, and that the results reported above were unchanged.

3.2. *(RQ2): Knowledge building*

The goal of the analyses was to test whether the experience increased student’s knowledge of the subjects and their ability in solving analysis and synthesis items. We allowed a cross-classified multilevel structure to the data, since students were initially nested into schools and then nested into groups. We report here the results of random-intercept-only models, since adding random slopes did not yield a substantial increase in model fit, as indexed by Akaike Information Index (AIC) and Bayesian Information Index (BIC) (data non reported here but available upon request to the corresponding author).

Predictors were time (post- vs pre-test), cohort (first and second), week (from Week 1 to Week 6), gender, grade, experience in programming (yes/no), favourite subject, frequency of daily use of computers, self-rated degree of knowledge of the subject, intention to enrol in a course at the Polytechnic School at Time 0 (yes-maybe-no), intention to enrol in a program in Computer Engineering at Time 0 (yes-maybe-no), upper secondary school type (prep vs vocational) and group size (1, 2 or 3, considered as a factor). Since our substantive interest was the association of Level 1 predictors and outcomes, metric variables were mean-centred within groups (Enders & Tofighi, 2007).

The Knowledge scores significantly increased from pre- to post-test ($t(101.99) = 2.36$, $p = .020$)[3]. We also found a significant main effect of favourite subject ($F(3,87.43) = 4.92$, $p = .003$) and of intention to enrol in a program in Computer Engineering ($F(2,175.79) = 3.72$, $p = .026$). In the former case, post-hoc tests revealed that students that reported Humanities (Category 1) as their favourite subject scored significantly lower than students that reported scientific (Category 2), ($t(87) = -3.09$, $p = .003$) or technical (Category 3) subjects as their favourite. In the latter case, students that reported the intention to enrol in the program scored significantly higher ($t(178) = 2.61$, $p = .010$) than students that reported to be undecided. Moreover, we also found that the higher the students’ self-rated knowledge of the subject at the pre-test, the lower the score ($t(90.36) = -3.53$, $p = .001$).

The Analysis scores significantly Increased from pr– to post-test ($t(102.02) = 4.06$, $p < .001$). It was also found that students in Grade 13 scored lower than students in Grade 12 ($t(88.47) = -2.60$, $p = .012$) and students that reported being experienced in programming scored lower than students that did not ($t(90.58) = -2.24$, $p = .027$).

The Synthesis scores significantly increased from pre- to post-test ($t(103.72) = 6.58$, $p < .001$). It was also found that students in Grade 13 scored lower than students in Grade 12 ($t(93.51) = -2.42$, $p = .018$), that

[3] For simplicity’s sake we do not report here the full set of effects and parameter estimates. These results can be accessed upon request to the corresponding author.

students that reported being experienced in programming scored lower than students that did not ($t(92.69) = -4.35$, $p < .001$), and that the higher the self-reported frequency of computer use, the higher the Synthesis scores ($t(93.68) = 2.41$, $p = .018$). Moreover, the main effect of intention to enrol in a program in Computer Engineering was significant ($F(2,177.08) = 5.11$, $p = .007$). Post-hoc tests revealed that students that reported the intention to enrol in the program scored significantly higher than students that reported to be undecided ($t(173.4) = 3.14$, $p = .002$) and then students that did not report the intention to enrol in the program ($t(175.2) = 2.06$, $p = .041$).

3.3. *(RQ3): Social Interactions and community building*

Regarding cognitive presence, the analysis of the grids filled in by the observers and compared with the tournament's ranking considering all the 47 groups, revealed that:

- Most groups dealt with theoretical and practical aspects separately, i.e., the observers noticed that most students designed on paper and discussed each task before coding it in the programming language. Only 8 groups started the coding phase directly, and all such groups ranked last or second-to-last in the tournament.
- 27 groups out of 47 achieved a 'high' label in performing tasks, 8 of them were in the second half of the ranking and 19 were in the first half. 14 groups achieved a 'low' label and only 3 of them were in the first half of the ranking. In this phase 6 groups were out of the level distinction: they did not finish more than half of their task. All the groups except for 1 were in the second half of the ranking.

Regarding social presence, it was observed that:

- Twenty groups were labelled 'high' considering social interactions between members of the group, 12 of them were in the first half of the ranking. 16 of them were labelled 'low' in social interactions, 8 of them were in the first half of the ranking. 11 1-person groups are not considered.

Regarding teaching presence, the elements observed include:

- In 9 groups the team spirit did not emerge, and no one of them appears in the first half of the rankings (this excludes eleven groups formed by a single member).
- During the experience, it was noted that each leader was (in his/her group) the most capable and charismatic person, except in 2 groups where the leader influenced negatively the work of the group (and the groups ranked last). In 13 cases a leader didn't emerge, in 10 of which the tournament's ranking was in the second half.

Overall, groups showed a good ability to develop cognitive presence. However, both the social and teaching presence dimension appear weaker.

4. DISCUSSION

This paper reports the results of a week-long immersive experience with upper secondary students to support their faculty choice. The aim of the experience was to introduce 88 students to the basics of the main disciplines at the core of the programme in computer engineering and to allow them to acquire and apply basic computer programming skills to program LEGO® Mindstorms® robots, thus offering them the opportunity to make direct experience of a '*typical faculty week*'. Overall, the proposed guidance intervention was designed to provide a concrete and realistic idea of Computer Engineering university activities. Quantitative data were collected via a questionnaire (pre- and post-test), while qualitative data were collected through an observer-filled grid of monitoring, focused on the behaviour of students.

Three main angles were considered. First, we focused on how a week-long immersive and situated experience could support upper secondary students in the upcoming course choice. Results suggested that after the experience some of the undecided students reported a clearer intention (either to enrol or not enrol), while students who already intended to enrol in the Computer Engineering program did not change their mind. The presence of students who reported an intention not to enrol should not be seen as an undesirable effect, since the experience was not meant to promote Computer Engineering, but rather to help students be more conscious about their choice.

Second, we explored the potential of an activity based on educational robotics to provide upper secondary students with some basics of Computer engineering. The results of the achievement tests suggested that student'' knowledge and abilities increased after the experience. This improvement was significant in all the three parts of the questionnaire (Knowledge, Analysis and Synthesis). However, some role seemed to be played also by some background variables, such as having scientific or technical subjects as favourites, a high self-concept in programming before the test, and a clear idea about enrolling in the course or at the school. A potentially contradictory result was that in the analysis tests students that never programmed showed the best results. This could be explained by the pragmatic approach taken during the experience, which might have worked better on uninitiated students than on students that were already able to program. Another unexpected result was that students in grade 13 scored lower than students in grade 12 in analysis and synthesis tests. Given that they did not have to choose a University program in the short term, perhaps grade 12 students had higher intrinsic motivation and, possibly, were working harder than their grade 13 counterparts to achieve good results in the final tournament.

Third, we explored how peer programming can promote social interactions and community building. Observational data was promising regarding the emergence of cognitive presence in teams, and those teams that did manage to achieve high cognitive presence also performed generally better in the activity. However, both social and teaching presence appear weaker, suggesting that for many of the participating groups social interaction was not positive, and the emergence of leading roles in teams was laden with conflict. This aspect is potentially critically important and should be further explored. One possibility is that the competitive nature of the activity, which entailed tournaments and explicit ranking of teams, negatively impacted on intra-team interaction by adding performance pressure and anxiety.

5. CONCLUSIONS

Overall, the outcome of the experimental experience can be considered positive, as it proved both supporting in career choice intention and successful in improving knowledge of basic concepts in Computer Engineering. Social interaction among students, however, was not always positive, and future work should focus on how to better promote community building behaviours in these kinds of intervention.

One of the main limitations of this study is the lack of a control group, which should have taken part to a traditional transmissive experience. Additionally, the sample only included volunteering students, and as such the proportion of students that present a high degree of interest in Computer Engineering is presumably higher in the sample than in the general population. Nonetheless, here we would like to point out our sample was not intended to be representative of the whole upper secondary student population, but just of that portion who is potentially interested to enrol in a specific course and is thus likely to attend other, more traditional orientation services offered by the same Universities.

In any case, we acknowledge our results are not easily generalizable, even if we believe similar approaches could be also adopted for other faculties (different from Computer engineering), provided that they are based on the same foundations, i.e. to provide students with a realistic and direct experience of the 'typical' faculty life, so to limit wrong initial expectations and – ultimately – decreasing the risk of future drop out. Future works should focus on a more systematic evaluation of the activity outcomes, as well as fine-tuning the proposed experience, which should in any case be interpreted as a pilot study.

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