

The Praktikum UPV Campus: Stretching closer ties between research at the university and students in secondary school

El Campus Praktikum UPV: Estrechando lazos entre la investigación en la universidad y los estudiantes preuniversitarios

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Abstract

The Praktikum UPV Campus is a huge internship program geared to students still in secondary education that permits them to develop a project within research groups of the Universitat Politècnica de València (UPV). Along that week, the students participating in the program document their projects in blogs. Once the projects are over they also record some videos in which they present their work and their findings. During the next year, these students presents their material to their respective classmates, still in the secondary school, showing examples of what they can already do at the university. The Praktikum UPV Campus also permits students to discover the degrees offered by the university, its facilities, and the life at the university campus.

Keywords: *STEM studies; project-based learning; secondary education; university; reverse service learning; Intervention; pre-experimental study*

Resumen

El Campus Praktikum UPV es un gran programa de prácticas dirigido a estudiantes que se encuentran todavía en la educación secundaria y que les permite desarrollar un proyecto en dentro de uno de los grupos de investigación de la Universitat Politècnica de València (UPV). Durante una semana, los alumnos participantes en el programa documentan el desarrollo de sus proyectos en blogs. Una vez finalizados los mismos, los alumnos graban además vídeos en los que ellos mismos presentan sus proyectos y sus hallazgos. Durante el año siguiente, estos estudiantes presentan su material a sus compañeros todavía cursando la educación secundaria, mostrándoles ejemplos de lo que ellos pueden hacer ya en la universidad. El Campus Praktikum UPV también permite a los alumnos descubrir las titulaciones de grado ofrecidas por la universidad, sus instalaciones y la vida en el campus universitario.

Palabras clave: *estudios de ciencias, tecnologías, ingeniería y matemáticas; aprendizaje basado en proyectos; educación secundaria; universidad; aprendizaje en servicio inverso.*

1. Introduction

The study of Science, Technology, Engineering, and Mathematics (STEM studies) has suffered a strong decrease during the last decade in Western Countries, if not in absolute terms (though were decreasing in relative terms) compared to other study opportunities, (UNESCO, 2010). The causes of this decrease are very diverse, see for instance (Becker, 2010; Prieto, Holbrook, Bourke, O'Connor, Page, & Husher, 2009), and it seems necessary to take actions to improve the perception that students in primary and secondary education have about Engineering studies and to approach science and technology to their classrooms, taking into account their motivations and aspirations (Alpay, Ahearn, Graham, & Bull, 2008).

The situation in Spain is paradoxical. On the one hand, since 2006 it has been observed a continuous growing of the number of students whose first preferences are health related degrees, up to being the ones with the highest demand for their admission. In 2013/2014 the demand has grown a 15.1%, and the accumulated increase in the last years is of an 88.6% (Ministerio de Educación, Cultura y Deporte, 2013). This pull effect has encouraged private institutions to offer even more places in health related degrees, pushing forward Spain to have the second largest average of the world in medical colleges, only behind South Korea (World Education News & Reviews, 2013). Such interest is mainly based in the perception of young students, and their families, that these studies have the highest opportunities for finding a well-paid job in a short future. As a matter of fact, 92.9% of the students that finished the degree in Medicine in 2009 have an employment after 4 years, being the highest average of all the degrees in Spain (Ministerio de Educación, Cultura y Deporte, 2014). On the other hand, the interest in Engineering studies and Architecture has been decreasing in the last years. In the academic course 2013/2014 there was a decrease of the 5.3% in the demand, and an accumulated reduction of the 23.3% in the last decade (Ministerio de Educación, Cultura y Deporte, 2013). These numbers seem to contradict the good perspectives of job opportunities in a short future for Engineering degrees, see for instance (Alkhatib, 2014).

In some countries, it is compulsory that students take one or more one-week internships during their secondary education. Internships during university studies are far more extended (Wikipedia). The word coined in German for such periods is Praktikum, which has been taken for naming the project under consideration in this work. Students usually take these internships with one of their parents or a relative. With such activities, students have a first contact with a workplace and can better understand what are the different tasks to be done in a job.

The initial idea of considering these internships in the university setting for secondary school students was partially taken by the authors from (Martínez-Iranzo, Naya-Sanchis, Díez-Ruano, & Vivancos, 2010). Nevertheless, this has been rethought as an outreach activity. The Praktikum UPV Campus can be understood as a reverse service learning in which students still in secondary school attend to the university for applying their knowledge to the development of a small research project. The outcomes of these projects are returned to the society either by blogs or videos, which are intended for:

- (1) contributing to a better knowledge by the future freshmen of the opportunities that each degree offers to them,
- (2) demonstrating that the contents in secondary education have a continuation and are the basis of more specific technological contents, and
- (3) promoting vocations for Engineering related degrees.

Starting from this approach, the Praktikum UPV Campus developed at the Universitat Politècnica de València is geared towards introduce 17-year-old students to the research and professional activities that can be conducted after having one of the Engineering degrees offered by the University. This program has 2 stages with an in-out approach. At the first one, students have the chance to have a one-week internship within a research group of professors at the university. Later, the experience is shared with their teachers and classmates at the secondary school, and through the social networks. So as to, during their stay at the university students document their projects in blogs. These contain not only the technical and scientific information needed for the development of the project, but also pictures and comments concerning the stay at the university, and their personal experiences and impressions about the academic life at the university campus.

More precisely, the goals of the Praktikum UPV project are the following. Firstly, to promote vocations on Engineering among the most brilliant students in secondary education. Secondly, to increase the knowledge about the contents and scope of the Engineering degrees among the school teachers and the rest of the classmates of the students that have participated in this campus. We expect that these experiences can motivate them and their classmates to choose one of the Engineering degrees offered by our institution. Finally, to generate on-line material about the contents treated on the Engineering degrees offered by the University. This material will be used for promoting the Engineering degrees during the next years.

The rest of the paper is organized as follows: In Section 2 a detailed description of the program is given, indicating the target group of students, the organization, and its development. In Section 3, we briefly report the effect and impact generated by the program. The follow-up activities carried out at the secondary schools are described in Section 4. Finally, Section 5 contains a summary of the conclusions.

2. The Praktikum UPV Campus

2.1. Target students

The promotion of university degrees among young students is not limited to the year before they can be admitted into a university, and the fostering of scientific vocations is neither limited to the work of secondary school teachers. In the last years, universities also play an important role contributing to both objectives. Examples of programs geared to students in secondary school with similar expected outcomes, but with different approaches, can be found in (Smith & Monk, 2005; Mehrizi-Sani, 2012; Villas-Boas, 2010; Bachiller & Conejero, 2015).

Of course, the sooner the students can participate in activities like the aforementioned ones intended for promoting their interest in science and technology, the better for inspiring them to finally choose an Engineering related degree. However, for the development of the projects in the frame of research groups at a university, a minimum of scientific background is required in order to permit the student to understand the theoretical background behind it. In Spain, compulsory secondary education finishes when students have 16 years. Later, they can take a baccalaureate (2 years) or some vocational studies (3 years of an elementary cycle and 2 years of an advanced one). After finishing each one of these studies, students can enroll in a university degree. The baccalaureate can be chosen among three types: Arts, Humanities and Social Sciences, and Science and Technology, (Boletín Oficial del Estado, 2007). In some high schools the Science and Technology Baccalaureate is not fully completed due to a lack of material resources (a

Science laboratory is far more expensive than a conventional classroom). This is a huge handicap in order to show the students all the opportunities that they can find later in an Engineering degree.

Taking all of this into account, the participation in the Praktikum UPV Campus is offered to students in secondary education that either have finished the first year of baccalaureate or the first year of the advanced cycle of vocational studies, that is one year before they can apply for enrolling in the university. This permits that the students participating in the campus share their experiences with their classmates. We expect that this will rise the interest to choose one of the engineering degrees offered by our institution, since it is during this period when a number of students take their final decision of which university studies they will apply for.

2.2. Organization of the internship

Participating in the Praktikum UPV Campus gives the chance to some students still in secondary education of spending a week within a research group at the university for developing a scientific/technological project. This stay is offered during the week after the secondary school students have finished their academic course, in Spain this is the last week of June. This coincides with the examination period of the university students. This has the advantage that many practice labs are not fully used and university teachers have a reduced dedication to teaching activities, which permits them to dedicate part of their time to mentor the Praktikum participants.

The rest of this subsection is organized into 4 parts. First, we explain how the offer of projects is designed; second, how the recruitment is done; third, what is the schedule of activities during the one-week internship at the university; and finally how to deal with the economic and gratifications that reward the teachers for their dedication.

2.2.1. Catalogue of the projects

Firstly, during the month of April the University decides the total number of seats to be offered in the campus. Secondly, these places are proportionally distributed among the different university schools taking into account the number of degrees offered by each one and the number of freshmen enrolled there.

A coordinator of the program at every university school is designed. Their main function is to recruit some professors that were interested in participating in the program, and to try to help them in the design of an interesting project for the students. The participation of the university teachers is not mandatory, however it is acknowledged by the University as we will see later. The coordinators also distribute the number of places assigned to each university school among the different projects. It is advisable that each project will be offered to just 2 or 3 students, in order that they can get really involved in its development, since when the students work in pairs they can discuss the contents with someone with their same level and background. This helps them to get confidence whenever new content is presented to them.

All the teachers participating in the program are called to a pre kick-off meeting in which the campus is presented. The scope and the precedence of the students is reported in order to help them to design their projects. Every teacher has to fill a form with the following points, that will be accessible by the potential candidates to participate in the campus, and will help them to choose the projects they like most:

1. *Title of the project.*
2. *Number of offered seats.*
3. *Teacher responsible of the project.*
4. *A short description (less than 100 words).*
5. *Option in high school or vocational studies more related to the project.*

In addition, it is also required that they provide the following information for inner use of the coordinators:

6. *A description of activities to be carried out each day by the student.* This is intended for helping the responsible of the project to define the project itself and the contents to be treated in it.
7. *A place where the student will have a computer with internet connection.* This habitates them to work in the project or to look for information concerning it.
8. *A tentative list of the university staff* (teachers, lab technicians, or PhD students involved in the mentoring of the students and who will take care of them during the internship).

All this information is validated by the coordinator of the program at each university school. These coordinators are also the link of the organizers of the campus with the teachers, and they are also responsible of presenting their respective schools to the students at the beginning of the internship.

We point out that some guidelines are provided to the teachers in order to define their projects. We recommend them to design it from two or three practice sessions which they already conduct at some university degree, and that they consider that with few preliminaries can be understood and developed by the students during the internship period.

2.2.2. Recruitment of student participants

Once the university has the complete catalogue of projects, this is announced and communicated to the high and vocational schools of the Valencia region, which total nearly 350 centers. A minimum mark of 8 over 10 in the first two trimesters of the present academic year is required to the students in order to apply to the campus. Moreover, a maximum of 3 students coming from the same school can participate in the program. This is intended in order to facilitate the participation of as many different schools as possible.

At each school the director and/or the academic counselor shared this information with the teachers of the Science, Mathematics, and Technology departments. These professors speak with their students with highest academic records that could be interested in applying to participate in the campus. Once some of them agree, they apply by registering in the website of the University, sending their personal and contact information, and submitting a certified copy by the school of their academic records during the present year. In addition, each student has also to select up to 5 projects among the catalogue previously indicated.

The University conceives that the participation in the campus is a prize for students in secondary school with the best academic records. Nevertheless, the university teachers and schools expect that the students participating in the campus were highly interested in the projects they are going to conduct. Since the students with the top academic records usually concentrate in very few degrees, their preferences should be also taken into account. This activity is seen by the university schools, and by their teachers, as an activity to promote the degrees in which they are teaching, so it is quite disappointing that they meet a student that confesses that he/she has already decided to take a non-related degree to them. Therefore, a

balance between interest in the project (order in preference) and academic records is set. This prevents that a student with very high academic records participates in a project with a limited interest to him/her. This was a little contradictory to some secondary school teachers. Several options were proposed and discussed, and finally we decided to follow the next procedure.

- (1) Each applicant has some mark at every project of their choice. On the one hand, the average of their academic records goes from 0 to 10. On the other hand, some points are given depending on their interest in each of the projects selected by them: 3 points for the first one, 2.5 for the second one, and so on, up to 0.5 for the fifth one. We point out that if a student does not indicate a project he/she is discarded of being considered suitable for it.
- (2) We order the applicants at every project in decreasing order of their marks.
- (3) We choose the project with empty seats and with the first applicant who has the highest score attending to Step 1. We assign him/her to this project and we remove him/her from all the other projects lists. We repeat this step until we ran out of seats at every project.

It can happen that some projects had no petitions, or the applicants to these project were already assigned to projects to which they have a higher interest. Therefore, a reserve list is done with the students not assigned to any project attending now only to their academic records. Each applicant with a preassigned seat is reached either by email or by phone in order to confirm his/her assistance to the campus. Once all of them have been reached and contacted, we collect all the empty seats (the ones not assigned and the ones that the preassigned students have refused to take after the pre-selection). This confirmation is required since no fees are demanded to the participants and in order to have all the seats in the projects assigned to students. This period of confirmations usually lasts about a week, and it is done at the beginning of June, as close as possible to the starting of the campus.

2.2.3. Development

As we have already indicated, the internship lasts one week, and it is usually held during the last week of June. All the participants develop their projects during the same period but within different research groups of the University. This permits to organize common activities to all of them in order that they can exchange experiences during this week.

The week before the campus is run, an institutional presentation is held at the University, usually on Wednesday or Thursday. The students participating in it are called to come and we invite one teacher from the same school of each student. We also suggest that these teachers were familiar with the project to be developed by their students. These secondary school teachers are expected to participate in the follow-up activities of the campus at their own schools during the next year.

In this session, after the welcome by the president (or vice-president) of the University, the students and their companions are taken to each university school by the respective coordinators. At each one of these schools a brief presentation is given to them, presenting also the degrees that can be taken there. Later, they participate in a tour for visiting the installations of the school. At the end, the meeting point for the next week is also shown to them.

The projects are to be developed from Monday to Friday of the next week. Each students take a total of 20 hours of internship for develop his project. On Thursday morning the teachers from the secondary school are invited to come to the University for knowing how his/her students are working at the projects of their choice, and in order that they can meet the university teachers that are supervising them. This is

necessary in order that the school teachers can later perform some follow-up activities at their schools during the next year.

Before lunch, the students at each university school meet all together in a computer room, where they can fill some posts in the blogs. There is a unique blog per year and school. Each student must label their entries with a tag for his name and for the project. Then, one can easily read later all the posts written by a single student and also all the posts related to every single project when it is shared by several students. Students are also encouraged to share their blogs with their classmates at the high or vocational school and their friends through the social networks. During the previous hours in the morning, some students have been partially uploading documentation and explanations of the tasks developed within each project to the blogs, but an explicit time to do it has been shown to be convenient, since some of them lack of time in the mornings, and this also encourages to the lazier ones to do it. The blogs are powered by Wordpress and they are open to any websurfer. A complete list of all of the blogs of the previous editions is accessible from (Universitat Politècnica de València).

Despite most of the students participating in the campus are keen with computers, very few have ever used a blog. A student from each university school is hired in order to help them with these tasks, but the role of these collaborating students is not limited to this. We ask them to encourage the students to upload pictures and videos, to give them ideas about what to write in the posts, to solve doubts and answer general questions about the university posed by the students, and to take them to the lunch place and to the place where the common activities in the afternoon are to be held.

In the afternoons, all the students meet altogether in order to take part in some traversal activities. We list them here for the sake of completeness.

- *Meeting each other.* Some ice-breaking games are proposed in order to facilitate that students of different projects and schools meet each other.
- *How to speak confidently in public.* This talk is intended to prepare them in order to later record a video on their project.
- *Let us do it!* A team-building game based on how to collect money for making a student-trip is proposed to them. This permits them to realize of the huge impact that share ideas and working in group can produce.
- *Social innovation.* This talk is intended to show them the opportunities that they have to help others with their projects and their work, and the impact that they can cause in the world with it.

As a final evaluation of what students have learned in the campus, they are encouraged to record a video with a presentation of each project. At least one video per project is expected. These videos are recorded during the week after the internship is over. In general, they are recorded at the same studios where the university teachers record their educational videos at the University, known as Polimedia. Further information on Polimedia can be found in (Wikipedia). In some cases videos with explanations in the lab of an experiment are grateful and also welcome. The videos with the presentations by the interns are uploaded to the YouTube channel of the University Praktikum-UPV in (Universitat Politècnica de València). Some reproduction lists were created to facilitate the vision of the videos by editions and university schools.

2.2.4. Economic part and gratifications

The Praktikum UPV Campus is performed with a limited budget. This only covers the meals of the students participating in it and the cost of hiring the students collaborators that accompany them at the lab

and in the displacements. The lodgement of the students will increment considerably the budget of the program, so it is not included. Nevertheless, this has not been a huge problem. The Valencia region and in particular the University campus are well-communicated by train with the towns and villages of the region. This facilitates that students from some far places can come to the University and return home in the very same day. On the other hand, some of the students also arrange to stay at the city close to the university campus with some friend or relative during the week of the internship. The only point about this is that if the students could meet after the activities in the university are over, they would have a greater personal experience not just limited to the academic environment.

The cost of the materials for developing the projects is not important and it is contributed by the university schools and departments within the expenses of lab daily costs. The participation of the teachers is considered by the institution in the internal academic formula for measure teaching quality and workload. This formula has been validated by ANECA, the national Spanish agency for the assessment of programmes, Higher Education institutions, and candidates that want to enroll in a university as a non civil servant member of the academic staff. Some of the teachers were also helped by Master or PhD students. Their contribution to the campus as mentors is certified as a collaboration on a teaching project. Offering this counterpart to teachers and their collaborators makes the program economically sustainable for the institution with a very limited budget, less than 10.000 euro for 200 students. However, the total cost of the project should take into account the costs of the participation of more than 100 teachers. Each with about 45 hours of average dedication to the project. The average annual gross salary of those teachers is around 35,000 euros per year (1700 hours per year). Therefore, the cost of personnel is 92,000 Euros. As the overall cost of slightly over 100,000 euros program to serve 200 students (about 550 euros per student).

3. Effect and impact

In 2010 the Praktikum UPV Campus was primarily held at the School of Industrial Engineering of the UPV as a pilot experience with 6 projects and 14 participants. The next year this experience was extended to 8 schools of the UPV across its 3 campus (Alcoy, Gandía, and Valencia). That year 114 students participated in 59 different projects. In 2012, a total number of 77 projects were offered up to 185 students from the local region of Valencia, more than half of them were girls. These projects were supervised by more than 100 university teachers, around 5% of the total number of permanent teachers of the university. As a result of the projects, 137 videos were recorded and uploaded to the YouTube channel of the campus (Universitat Politècnica de València).

Once the campus was finished the students were questioned online about their internship. The poll was answered by 143 of the 185 participants, which is the 77.3% of them. The results are summarized in Table 1. In addition, a general question about the evaluation of the campus was posed. A 54% of the participants evaluate the activity as very good, and a total of 90% as good or very good.

Table 1. Results of the evaluation of the Praktikum UPV by the student participants

	Totally disagree	Disagree	Medium	Agree	Totally agree
I liked the project I took (it was interesting)	1%	1%	15%	36%	47%
Teachers (and collaborators) were involved	1%	3%	11%	26%	60%
The common activities were interesting	1%	9%	30%	43%	17%
The coordination was good	1%	0%	14%	51%	35%

Source: Compiled by the authors (2015)

Finally, the impact of the campus was also measured in terms of enrollment. Nearly 70% of the students participating in the campus enrol in a degree of our university in two years time. The majority of students that did not enroll either choose a degree on health studies, mainly Medicine, or enrol in a university which offered the opportunity to obtained a double degree in one or two more years time, that it was not yet permitted by our institution. This opportunity has been recently considered as a consequence in part of the results of this campus.

4. Follow-up activities

The core of the program is developed at the university. However, we encourage the teachers from secondary school that accompanied their students in some moments of the campus at the university to do some follow-up activities at their schools within their classes. Once the internship was over and all the videos were recorded and uploaded, we propose them to design an educational activity based on the project developed by their students at the university and using the multimedia content they created. For doing this, we suggest them to choose a topic of one of the subjects they usually teach at the school, in particular the one more connected with the project done by the student, and to present this activity as a complement to the syllabus of these courses.

This educational activity is expected to include somehow an exposition by the student that participated in the campus. In his/her presentation he/she reports to thee classmates not only the project developed during the internship, but also some facts about the life and activity in the university schools. We suggest that this activity will last one or two classes and it will include a review by the teacher of the content developed by the student. In order to contribute to the design of these activities, a brief scheme was delivered to the secondary school teachers in order to complete a technical sheet with the following items:

- (1) *Title of the activity.*
- (2) *Author and student information.* Affiliation and contact.
- (3) *Information on the project from the university.* School and department of the university where the project has been developed. University degree related with the content.
- (4) *Context.* Course, subject, and lesson in which it is presented.
- (5) *Resources.* Duration and material needed.
- (6) *Description of the activity.* We suggest to explain the activity in 4-6 pages including pictures and tables if needed. A template with formats is also provided to the teachers to facilitate their work.

- (7) *Bibliography*. Books, web sites, and multimedia content apart from the blogs and videos created by the student within the internship.

These sheets were submitted to the university. After revising them and suggesting some modifications, the secondary teachers receive a certificate from the University for having participated as tutors of the students in this Praktikum UPV Campus. Furthermore, we have an agreement that this certificate is officially acknowledged by the regional educational administration with the condition that the activity was to be considered in the academic program of the school for the year in which the follow-up activities are done. In 2012, we receive 45 sheets and only 36 of them were elected for publication in an electronic book (Conejero, Albors, & Vivancos, 2015).

Finally, we point out that the online material, videos and blogs, produced by the students of the Praktikum UPV Campus is used to be shown during the Open Days that the University arrange every year for the future eligible freshmen. The corresponding videos and blogs of each university school are linked by their respective websites, from some location where the information for future freshment is gathered. Up to now, the Youtube channel of the Praktikum UPV Campus adds more than 30,000 views.

5. Conclusions

We have presented a model of an internship campus held at a university with the interest of promoting vocations on Engineering, Science, and Technology. This campus has permitted to the institution to generate audiovisual content to promote their degrees from projects developed by students still in secondary education. Their contributions has permitted to stretch ties with secondary schools and with some of their teachers, and to reinforce to secondary school students that the contents they are studying in secondary education are useful, valuable, and not so far of real applications. This also permits to present a point of view of Engineering degrees adapted to real applications and services. In a short future we expect to consolidate the relations started between university and secondary school teachers in order to develop new collaborations.

We finally point out that a majority of the participants are happy with the project, and 70% enroll with the organizing university within two years time. However, it is quite hard to certify that this was a result of their prior interest in science and engineering before partaking in the project or a result of the 'Praktikum' is not discussed. The choice of a degree is a result of lots of variables, and it seldom depends on a unique factor. In order to analyze the impact, institutions must take this into account when organizing outreach activities, since there is no a direct correlation of what you give and what you receive.

Despite the high rate of participants who ultimately enroll in courses at the UPV, the satisfaction of participants shown in the polls, and popularity of Youtube channel visits; we lack the data to make a more accurate estimate of the actual impact. In this sense, we do not know if, through participation in the praktikum, we have raised the interest by the Technology & Engineering degrees in high school students. For example, have it significantly changed the rate of students who, coming from a center participating in the praktikum, choose to enroll in courses at the UPV? Or the intention to enroll in a degree in Technology & Engineering? Are rates higher than those in centers not involved in the praktikum? Have it increased the number of visits to Open Days? Is it higher in centers that have made the praktikum than in similar centers without participation? These questions should be addressed in future research to ascertain the actual impact of the experience.

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