LET’S GO THE UNIVERSITY LABORATORY: A SUCCESSFUL COLLABORATIVE EXPERIENCE

C. Vázquez, J. Pérez, J. Espinosa, C. Hernández, D. Mas, J.J. Miret

Grupo de Docencia en Óptica y Ciencias de la Visión (DOCIVIS)
Departamento de Óptica, Farmacología y Anatomía.
University of Alicante (SPAIN)

Abstract

In order to encourage high school students to be interested in Physics and Optics, the Technological and Educational Innovation group “Teaching in Optics and Vision Sciences” (DOCIVIS) has been working closely with numerous secondary schools within the territory covered by the University of Alicante (UA) for four years. The collaboration is framed within the UA’s Research Networks, that are directed to preparation sections to entrance University. The main objective is to promote the coordination and teamwork between teachers from different areas and/or educational levels. Main initiatives are the research on the design and planning of the teaching-learning proposals, the improvement of the adaptation of students to the University and a better conceptualization, understanding and characterization of the degrees. Therefore, along last four years, we have received in our labs to 625 high school students and also, in the latest edition, students from 4th year of compulsory secondary education (ESO). Students have become the true protagonists of the learning process. It has gone from receiving in our facilities students from just 3 centres in the first year, to 14 centres in this one, so we think it is time to gather and reflect on all the work done.

Keywords: High School, laboratory experiments, collaborative.

1 INTRODUCTION

As it is clear from the 6th Science and Technology Social Perception Survey (2012) by the Spanish Foundation for Science and Technology (FECYT) [1], a low percentage of Spanish has little or no interest in science. They argue as the main reasons that "it has no interest," and "they do not understand". Though, compared to 2010, there is an improvement in the age group between 15 and 24 years, the general trend has not significantly increased. One reason could be the fact that 41.9% of the population receives low or very low scientific education. Therefore, society's interest in science should be improved because, if not remedied in some way in the medium term, this will lead to a decline both the quality of research, and the capacity for innovation, and therefore the ability to function in today's knowledge society.

The interest in this topic is reflected as one of the specific objectives of the State Plan for Scientific Research, Technology and Innovation 2013-2016 [2]. It appears as an objective "Increasing scientific culture, technology and innovation of Spanish society and the dissemination of results of scientific and technical research and innovation publicly funded". In this situation, it is well known to members of the university community, that the interest of young in studying Science and Mathematics is falling alarmingly. According to the report, "Facts and Figures of the University System. Year 2011/2012" developed by the University Coordination Council, the decline in the last decade in the number of students is alarming, 27.3% [3]. Physics Studies have lost about 50% of students in the last 20 years and only a few studies, such as Biology, contain the general downturn in Science.

It is clear that the combination of factors such as finding an easy, comfortable and well-paid job, the subject choice model existing in Spain within post-compulsory education, the difficulty and "overexertion" which is often attributed to this type of studies, the discouragement of both secondary and university and the obvious poor ability of learning methods ("Science does not sell well") has not benefited the containment of this phenomenon. As the Dr. Angel Forner [4] states, the necessary conditions for success are motivation and preparation.
In this type of Studies, it is often asked by students and also by a large number of teachers, a recurring and demotivating: "What is the point what I am studying? What is the use in subsequent studies or career opportunity?" Obviously, faculties, especially that found in initial courses where basic training is conceived as should, must be able to give a clear answer to those question.

For all the above, the technological innovation-educational group DOCIVIS (Group Teaching in Optics and Vision Sciences) part of the University of Alicante [5] has as main objective the promotion of interest in the subjects of a scientific and the effective collaboration in scientific and practical training for future students of the University of Alicante. We suggest the development of joint activities between the University and secondary schools:

1. To take advantage of previous knowledge and experiences of students in order to incorporate them into the planning process of their teaching and assessment of learning achievements.
2. To improve the attitude of students regarding scientific and technical subjects, mainly those that are thought to be useless.
3. To start students to the scientific methodology, treating it as a multidisciplinary and noting that the scientific areas are not unrelated to each other.
4. To insist on the importance of the core subjects for further application in the development and understanding of later, more applied subjects.

Following on this line, in the academic year 2012/2013, we have developed the fourth edition of "Network for collaboration with secondary schools for pilot training high school students. Introduction to laboratory work" framed in the Networks of Research of university teaching of preparation sections to entrance to the University [6], [7], [8]. Throughout the past four years, we have received in our labs 625 high school students of 1st and 2nd year and also, in this latest edition, the fourth grade students of Secondary Education (ESO).

The students have become the center in the laboratory sessions that are aimed at that they were the true protagonists of the learning process. During that time, we have gone from receiving three schools in our facilities to 14 centers in this course and we think it is time to gather and reflect on all the work done. The origin of this performance was the attempt to get awakening, to the extent of our ability, the interest in the scientific subjects. The understandings of the scientific and technological content they generate allow the student a real contact with laboratories of the subjects involved in the project. Also, we note very positive results in the development of these activities, which allows the involved faculty to learn about the skills and attitudes of the future pupils. This permits to modify, adapt and improve the teaching process.

2 METHOD

This network offers students and teachers in secondary schools and state-subsidised schools in the province of Alicante, conducting practical sessions in the teaching laboratories belonging to the Department of Optics, Pharmacology and Anatomy at the University of Alicante. Since what we look for is that high school students and their teachers find these sessions immediately useful, they are designed so that they have a direct relationship with their current studies and complete theoretical concepts covered in class. Teachers from each school may propose the study of the curriculum they consider more interesting for students at that time, and they can evaluate these experimental activities as they wish. The Network is open to any suggestion of teachers. In the latest edition, the number of students in the first year of high school and 4th year of secondary has increased, which has meant extra work to adapt the session and prepared at their level for optimal use.

What began years ago as a laboratories open day to a school that was very interested in participating in a pilot project, has become in performing physical laboratory experiences to 14 secondary schools and a total number of 265 students in this course. Obviously, the number of spent hours and the complexity of the temporal organization have significantly increased in successive editions, requiring extra effort from teachers.
The implementation of the activities is generally carried out, after the first three months of the year. The reason for this choice is twofold. First, the teachers from high school have had adequate time to develop the curriculum and students come with some concepts already acquired. The second reason is to make the time intervals in which the students of the University do not have to use the facilities and resources available. However, it is customary that some center applies its realization in advance, making them coincide with the theoretical development of concepts related to both Physics and Chemistry (e.g., atomic models and their relationship with light spectra).

Depending on the size of the groups, to achieve the best use of available resources and schedules, we proceeded to divide the group into two subgroups. Each subgroup performed a practice in a different laboratory during a session that last about 90 minutes. After a half hour break, exchange subgroups. Within each subgroup, the students are divided, depending on the capabilities of the laboratory and the number of students. The teachers of the schools and their pupils have the scripts prior to the practice in order to work with the concepts involved before in their classes. During the laboratory sessions, the faculty remembered and stressed on the most important concepts and purpose of the meetings, helping at all times practical realization. One must not forget that the student is the real protagonist, the one that takes measurements, performs calculations and arrives at results. He/she is not a mere spectator to see how the teacher does and describes. In general, we observe that the students are receptive and to "do Physics" gets them excited. As for the teachers in the school, it is interesting to note that the level of involvement and effort is perfectly reflected in the group of students.

3 RESULTS

In order to assess as objectively as possible the work done and to identify the weaknesses and strengths of the experiment, we polled students and teachers of the participating centers. It consisted of the realization of very simple surveys at the end of the sessions. Let us show you the most relevant results obtained during the 4 years we has been doing these collaborative experiences.

First, we characterize the participating students. In total, 625 students have participated in our network in these four editions. The evolution is shown in Fig. 1. As can be seen, in the 2011 edition, there was a decline in the number of students involved. This is because it coincided with the launch of the new Degree in Optics and Optometry, which was simultaneously conducted to the existing Diploma in Optics and Optometry and makes it impossible to have all the time that would have been necessary the laboratory. They were busy, either by Grade students or by the students of the Diploma and made it difficult to admit the greater number of centers.

![Figure 1. Number of participants in the various editions](image-url)
It is clear that the number of centers participating in our practice sessions has grown significantly. This was helped by the fact that, due to a request from the Faculty of Science of the University of Alicante, we have participated in the program “Come to practice to the University”, funded by FECYT in its activities to promote scientific culture. The outward projection has been increased and, this increased visibility of our work has enabled centers across the province to be interested and involved in this project. A remarkable fact is that we observe that the centers always repeat the experience in subsequent years. Some of them are participating in all editions, and do so by providing an increasing number of students. This last fact is noteworthy since, as we already mentioned, the number of high school students enrolled in 2nd Physics is significantly declining and, therefore, few centers maintains large groups of this subject.

In the Fig. 2, we show the students distribution per course. Most are students in the 2nd and 1st high school (ages 17-18). In the last two editions, there has been a remarkable increase of 1st year students and also of 4th compulsory education (age 16). The increase observed in this group of students is considered very beneficial because it opens the door to repeat the experience in successive editions. Many centers have both orally and in the surveys expressed his desire to return. We emphasize that, for this year students, practices have been suitably modified to suit your skill level.

![Figure 2. Distribution of participant students by year](image)

If we analyze the gender distribution of the participating students in the different calls, as shown in Fig. 3, the majority are men, increasing this number slightly over the years. The involved students usually study the subject of Physics and Chemistry, if they are from 1st year of high school, and Physics, if they are from 2nd year of high school. We also can observe that about two thirds of the students are male, indicating that some gender stereotypes still remains in Spanish society [9], [10], [11]. From DOCIVIS group, it has tried to make the students belonging to the modality of Health Sciences, students in the subject of Chemistry and mostly female, to participate in these activities. We have incorporated practical sessions where concepts that are treated at the border between Physics and Chemistry. As it can be seen, social stereotypes continue to set the trend.
Once characterized the participating students, we analyze what we consider the most important points reflected in the survey. A number of survey questions are focused on the preparation and format of conducting laboratory sessions. First, we analyzed the degree of difficulty of the used concepts. In all calls, over 80% of students consider the depth level of the concepts studied to be normal. Only 5%, in a particular year, it considered high. This indicates that the degree of difficulty, both in theory and practice, of the sessions proposed by the network is properly suited to students who attend the sessions (Fig 4).

Another aspect to consider is the duration of the session. The participant students have to take profit of all the time and also end the session with a good feeling. From the first time, we questioned whether three hours of practice, with a little intermediate break, would be the ideal time for young students unaccustomed. In the available time, instead of performing a lab concerning a particular topic we choose to make two shorter sessions (90 minutes per session) to treat different issues pertaining to their curriculum. This allows students to relax, change the workspace and return a new activity.

As it is shown in Fig. 5, on the first year a small percentage, though valuable, stated that the time was short. In subsequent courses, we made small changes to adjust the time allotted for the completion of the proposed activities.
One of the most interesting items for us is the reference to the usefulness and acceptance of these sessions. Just like it is shown in Fig. 6, in all editions and to the vast majority of students, more than 95%, they found quite or very interesting the work. In the same way, as a reflection of this fact (Fig. 7), virtually all of the attendees would make these sessions again.

Finally, we observe, in Fig. 8, that, together with the interest generated by these sessions, students also qualify as useful for their education, across all edits. This fact confirms the line of work followed since one of our goals is that the sessions are a complement to their training and, from this result, we see that the goal has been reached.
To conclude this analysis, it is necessary to briefly mention the comments and suggestions provided by the Middle and High School teachers who accompanied the students in the different sessions. The results are very positive since throughout all editions, as reflected in the survey respondents, 95% of the participating teachers considered very interesting and 5% interesting. This acceptance by teachers has been one of the reasons annexed to the progressive increase in the number of participating centers. These results show that the effort is worth and the wide acceptance of these activities is undisputed. The vast majority of teachers evaluate and qualify the students, in one way or another, the activity carried out in our laboratories, considering that it is one of the activities to perform by the students during the course.

4 RESULTS

Once analyzed the obtained results in the different editions of the Network and the evolution of these over time, we are able to say that the results from this project are clearly satisfactory for all parties involved. Obviously, this leads us to desire continue this experience. Now, it is undisputed that the complexity of its development has been increasing at the same time has increased the number of centers that visit us. There is a physical limitation on the availability of laboratories and staff too, since the dedication of the involved teachers depends on the hours we have free outside our official dedication, since these activities today have no kind of recognition from the University. However, our purpose is to go ahead despite the difficulties. The commitment with quite of the participating centers, which have secured their presence to the next course, helps us to continue the project.

5 ACKNOWLEDGEMENTS

This work was partially funded by the project "GITE-09003-UA-DOCIVIS." University of Alicante

REFERENCES


http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.7eeac5cd345b4f34f09dfd1001432ea0/?vgnextoid=83b192b9036c2210VgnVCM1000001d04140aRCRD


