Chapter V

Comparative reflections regarding the educational use of different VI instruments

VccSSe project involved in the two editions of the course Virtual Instrumentation in Science Education a number of 362 teachers of Mathematics, Physics, Chemistry and integrated Sciences that teach in lower and upper secondary schools of the participating countries. As a result of the curse, a number of 213 didactic products were designed each of them including a virtual application of different type (demonstration, experiment or exercise) associated with a science lesson plan.

V.1. Teachers' voices in VI based Science Teaching and Learning

During and after the course teachers involved reflected upon the impact that VI tools and application may have and actually had in insuring the effective science contents, by filling in a questionnaire regarding the general attitude towards virtual instruments used in classroom settings, their opinion regarding the impact VI have on different aspects of science teaching and learning, the difficulties encountered in using Vis in science lessons and the intention of using such tools in the future as well as the adaptations they would make in the future situations when using VI tools.

A great number of the responding teachers regarded virtual instrumentation applications as a source of inspiration for their teaching actions that should be used as an alternative to traditional tools, and as a means for improving students' understanding of abstract concepts. Generally, teachers did not find direct correlations between use of VIs and improvements in students' learning skills.

A part of the Spanish teachers reported that even though the term Virtual Instruments is not very well known to them, they enjoy and find natural to use electronic simulations and virtual applications as long as they are motivating for students.

In fact, as far as different aspects of teaching and learning and impact of VIs, the best scores were obtained to the item regarding improving students motivation for learning. Most of teachers in different countries reported that VI applications were the most useful for creating and maintaining students' interest for science topics as well as in obtaining better results in evaluations. This last aspect correlates with good scores given to improved understanding of concepts. Good scores were registered also in students' interactive learning mediated by VIs.

As for most of the teachers using virtual science applications in the classroom was one of the first experiences of this type, difficulties were reported in management of the classroom especially in: evaluation of students performance as well as in access to hardware or general management of students.

A number of teachers that work in more structured and less flexible curriculum systems (for example, the Romanian teachers) were concerned with meeting curriculum requirements through such special lessons. Indeed, displaying and working with virtual experiments in teaching and learning may be time consuming in certain school settings, for instance in case of a low number of computers for individual intervention, or in the case of teacher or students' low computer use abilities, or may not insure for hands on intervention for all students with consequences for their learning motivation.

Nevertheless, most of the teachers declared that lessons that include VIs were successful or rather successful and that they would decide to use again such educational applications, provided that they will have better and constant access to computers and would be able to involve students more in the creation and modulation of virtual learning spaces and experiments.

V.2. Students' voices about VI based Science Teaching and Learning

An approximated number of 3000 students were involved in the lessons designed during the courses carried on. Consequently, they had the opportunity to reflect on the impact of virtual

experiments and tools for their learning, motivation, on the aspects they liked and on those which did not like in the Science classes based on virtual applications.

A considerable number of students expressed their preference for the use of computers in their classrooms as suitable to their culture and era in contrary to the use of paper and pencil. In their own words "*The lesson became easier than in the paper and blackboard environment; when using computers, low grade students understood the lesson*"(Greek student) or "*The application conducts activities at your own pace and you can know or that happens at the time and safely*" (Finish student). Some students also expressed their preference for group working while using VT&E, or, more general, for the work atmosphere the presence and use of computers create.

A great number of students appreciate the opportunity of interacting with the virtual experimental space. Specifically they mentioned the following tools manipulation: a) drawing, b) experimenting, c) understanding, d) feelings, and e) scaffolding.

Drawing Students said that they were attracted by the possibility to draw colorful shapes using its tools, particularly in case of Cabri Geometry. In fact, this possibility helped them become interested and focused during the specific lesson. Some students also expressed that the construction of shapes was more precise, correct, clear and easy than the constructions in the blackboard. These students suggested that drawing within Cabri doesn't leave many opportunities for mistakes. Students also found it easy to measure some geometrical entities within Cabri.

Experimenting with software: Students were impressed by the possibility of dynamic experimentation with geometrical shapes (with Cabri Geometry, by using the 'drag mode' operation) or with changing variables involved (in case of Crocodile Clips, LabVIEW or GeoGebra). Students realized that, using this operation, they have the ability for easy and fast creation of multi-forms of shapes, while at the same time conserving their properties. They came to understand the dynamic transformation of shapes as motion of shapes. In fact, students came to see dragging or changing variables as a dynamic (fast and easy)

transformation of geometrical shapes or spaces and the correspondent measurements: "*we can observe and study many forms of the same geometrical construction simultaneously*" (Greek student); "*you can change the data of the experiment as you feel*" (Spanish student).

Understanding of concepts: Students also expressed that they could acquire better, easier and faster understanding of concepts when dynamically experimenting in a safe mode with physical, chemical or geometrical spaces. Students expressed that "*Some difficult topics for the typical paper and blackboard environment became more easy and understandable by the use of technology*" (*Greek student*). Other students also commented that "*we became active and quickly understood the topics in question*" (Greek student), or that "*It is easier to understand the concepts and experiments with the computer helps us a lot*" (Spanish student), "*Helped me to better use my imagination for understanding and exploring Physics concepts*" (Romanian student), "*It is easy to explore the effects, the influences, the changes and effects*" (Finish student), "*Manipulating the aircraft: capacitors, diodes, transformers. Not only do you see represented on the board and in the book and you have to imagine that happening*" (Spanish student), "*easier than learning by reading a book*" (Finish student).

Feelings about the use of VIs: Here as well, some students expressed that when they participated in lessons where Cabri was used, they felt pleasant, entertained, interested and focused, more motivated. Some other students expressed that, compared to paper and pencil; they found using of software as creative, 'nice' and interesting, a new experience and easy to explore.

Scaffolding within software: Students expressed that everything was helpful when they used VT&E. Specifically; they realized that the use of visual images was very helpful for them to easily understand the concepts in question. In addition, they expressed that the tools provided by the software helped them to easily use rules or theory, to automatically perform some specific geometrical or physical constructions ("*from the library of tools*") and measurements as well as automatic tabulation of numerical data. Finally, some students emphasized the diversity of tools provided as helpful to construct, elaborate or observe a plethora of demonstrations, problems of experiments.

General remarks: Students characterized the way of teaching by using of Cabri in their school practices as: "It is audacious and modern to school practices", "*it is good, visual, interesting and special*" (Greek student), "attractive through various colours and shapes one may create" (Romanian student) "*this method of teaching is fast, interesting, direct, effective, easy to use and easy to understand*" (Greek student), "you may perform difficult chemistry experiments safely and cheaply" (Romanian student), some of the students have seen the experiment as a regular activity in the classroom and not as a very new thing (in case of Spanish students). Contact with VI is thus, as natural as with any other technological item. A great number of students felt more involved in lessons, with consequences in improved "*intrinsic motivation*" (mentioned by Polish students).

A minority of the students experienced some difficulty using and learning to use the software. Regarding the former, students noted that drawing or manipulation of variables was time consuming. Regarding the latter, students noted that there was no help from the teacher during the use of the software and its complexity and difference from traditional mean made it hard to learn how to use. A few students also remarked that the conditions under which the experiments where carried out were less than satisfactory, namely, there were too many students for the computers available (case of Greek, Romanian, Polish and some of Spanish students), it was dark or noisy in the room; the experiments were not very well organized in terms of facilities (Greek and Finish students) or lesson management (Polish students). Different students mentioned the fact that the time of computer use was not enough or that the classes were too short. Very few students expressed the precise preference for the traditional exploration of science concepts.

Without exception in all groups of students the majority appreciated that the virtual experiments helped them to understand the science concepts and expressed their wish for more lessons of this type in a regular (over 75% of respondents) or occasional manner (10 to 25% of students).

Many of the students remarked that they would like to participate in more lessons where virtual tools and experiments will be used, in their daily lives. If possible, they would like this method to be used in all subjects and a variety of science topics, with more attractive and diverse layouts.

In conclusion, we appreciate that the project offered the occasion of experimenting with new and innovative pedagogical tools for optimizing the teaching and learning of Science subjects, topics that usually put problems to ordinary students. Apart from a motivational force and a more interactive learning atmosphere, the use of virtual tools and experiments in the classroom helps imagining abstract processes, brings concepts into applicative, concrete concepts, favor cooperation, manipulation of reality and formulation of conclusions through own cognitive efforts.