RELATED ASPECTS TO THE PEDAGOGICAL USE OF VIRTUAL EXPERIMENTS

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1. Introduction

At present times, the educational process includes many ICT based methods for teaching and learning. Virtual instrumentation is not an exception - it is completing or replacing the experimental part in various cases. Many instruments not only allow users to conduct measurements but also present briefly fundamental theory of the phenomena or/and provide full information concerning the experiments (e.g. how to switch on instruments, make connections, set correct parameters and run experiments; how to collect and analyze data and verify the obtained results etc). In general, the virtual experiments are equipped with applications that simulate phenomena and processes, and also model instruments and experimental measurement systems. The educational virtual experiment must be well framed in the lesson context. Thus, a lesson plan has to be designed carefully, good structured and guided to capture and maintain the interest of the student - for this reason, the interactive components in a lesson are acquiring more and more importance. The interaction can be carried on in several ways according to the specific educational goal: *animations on selected files*, *simulations* and *web-experiments* [1], [2], [3].

As a general rule, the execution of web-based experiments requires the creation of specific interfaces which, in the case of Science applications, consist of a multimedia simulation for the communication between the learners' commands and the target system. For this purpose, specific software was designed by different companies for covering especially the Science areas. In this way, special software applications provide their own interfaces, where simulations can be created easily. To spread the use of virtual instruments for educational purposes, the three years Socrates Comenius 2.1 European Project called "*VccSSe - Virtual Community Collaborating Space for Science Education*" was proposed in 2006. In the frame of this project, specific *VI* software applications were selected by the partnership to be used in the training process of in-service teachers who are involved in Science teaching.

2. The Training Steps

The *VccSSe* project - carried out by 9 partner institutions from 5 different European countries (Romania, Spain, Poland, Finland and Greece) - was design with the declared aim of adapting, developing, testing, implementing and disseminating training modules, teaching methodologies and pedagogical strategies based on the use of virtual instruments, having as target their implementation in the classroom through ICT tools.

One of the most important outcomes of the project was to create and develop specific materials for training on using *Virtual Instrumentation in Science Education* [4]. The training materials were dedicated to in-service Science teachers from all the educational levels in the partners' countries. The preparation of the *VccSSe* training modules was made following two directions, simultaneously: the first one targeted on the creation of the content of the modules, related training materials and assessment tools; the second one used a strong technical background to develop and implement ICT instruments that support the training. In this sense, the project team have implemented an e-learning platform for supporting the related activities and developed the *e-Space*, a repository of virtual experiments that were used as examples in the context of training. The training modules introduced specific concepts of virtual instruments, available software packages and web examples, pedagogical methods and also particular and didactical elements for the selected educational platforms: *Cabri Geometry II Plus*, *Crocodile Clips*, *LabView* and *GeoGebra*. The in-service teachers - function of their background and goals - were required to choose one of the software environments for understanding its main functions and creating at least one learning object that has to include a *VI* application. Their lesson plan - designed under a specific *Template* - proposed explanations on the concepts to be learnt and also promoted a *VI* experiment for students with a significant level of interaction.

3. Results and Discussion

Following the "*Virtual Instrumentation in Science Education*" training modules, the teachers learn to develop at least one virtual experiment which they can use it in the classroom. This experiment represents the main product of the training activity. Together with the lesson plan, the experiment was uploaded in a special *Products Matrix*, a database especially designed for hosting the in-service teachers work and results on using virtual instruments for educational purposes. The *VccSSe Products Matrix* is accessible from the project website and its content is available to any project website visitor. The first page of the Matrix offers information of the number of the products - per partner institution - uploaded to the Matrix, in each course edition. Beside the final products of each course participant, there are provided also information related to the lesson name, students level, area/category, teacher's name, school, keywords. At the end of the second year of the project, over 180 teachers had created their products and most of them also implemented the learnt methodologies in their classrooms. The lesson topics are selected by the teachers from different scientific areas (Mathematics, Physics and Chemistry) and different style of approach [5]. In Târgoviste, 13 in-service teachers attended the first edition of the course and other 11 finalised the second one. 7 products were designed for primary schools (most of them for Mathematics lessons, using *Cabri Geometry II Plus*), 11 products were created for lower secondary schools and other 6 for upper secondary schools.

Trying to assess the pedagogical use of virtual experiments, those 24 Romanian in-service teachers involved in teaching activities in Dâmbovița County (Romania) who attended the "*Virtual Instrumentation in Science Education*" training modules expressed their feed-back in three specific web-evaluation questionnaires: the initial one (before the course), the final and the impact ones (after the course). The questionnaires had particularly questions dedicated for evaluating the level of their knowledge acquisition on creating and using virtual experiments in the classroom, achieving the goals and purposes of the *training modules* and rating the presented virtual instrumentation software (*Cabri Geometry II*, *LabView*, *Crocodile Clips* and *GeoGebra*). At the same time, the teachers were asked to assess how important became the virtual instrumentation for them (as teachers), which were the qualitative aspects improved in the teaching process, which were the difficulties encountered in the implementation of the virtual experiments and what are the future improvements on using the virtual experiments in the classroom. Here are just some considerations resulted from the teachers' answers.

Related to the achieved goals, the in-service teachers were asked about their knowledge gained on two different aspects: one directed to the capability on reproducing virtual experiments prepared before and the other addressed to the possibility to design virtual experiments using the learnt software. Having in view that the training module covered 42 hours, their feedback to those questions was appreciated generally as very good, over 70% of them expressing their knowledge on using and creating of virtual experiments for their area at a high level. Figure 1 illustrates the rates of their answers.

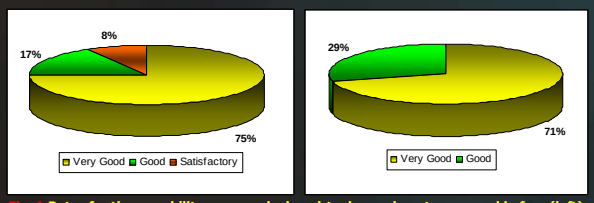

Fig. 1 Rates for the capability on reproducing virtual experiments prepared before (left) and designing virtual experiments using the learnt software (right)

The benefits expected from the classroom when using *VIs* were rated in relation with the following fields:

- improving students' understanding of Science contents;
- improving students' learning motivation;
- supporting correct application of knowledge;
- increasing the Science didactics awareness;
- improving the understanding regarding students' learning and motivation;
- challenging for improving the teaching behaviour.

The most important benefits were expressed in strong relation with students' learning motivation - over 90% of in-service teachers emphasized on this aspect when working with virtual experiments. Even for the other fields, a percentage of over 70% felt that the introduction of virtual experiments in the classrooms conducted to real benefits in terms of understanding the concepts, gaining the knowledge and improving the teaching behaviour. Figures 2 - 4 present the rates of the teachers' answers. It can be remarked that the analysed fields gained an important improvement due to the *VIs* using during the Science lessons.

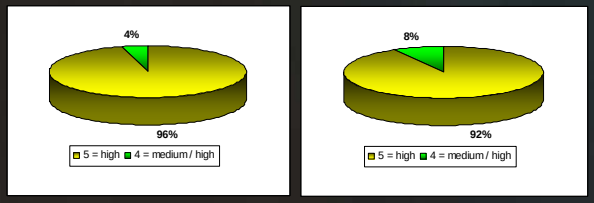

Fig. 2 Rates for the benefits expected from the classroom when using VIs related to: improving students' learning motivation (left) and improving the understanding regarding students' learning and motivation (right)

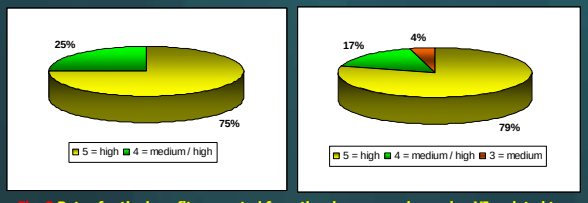

Fig. 3 Rates for the benefits expected from the classroom when using VIs related to: improving students' understanding of Science contents (left) and supporting correct application of knowledge (right)

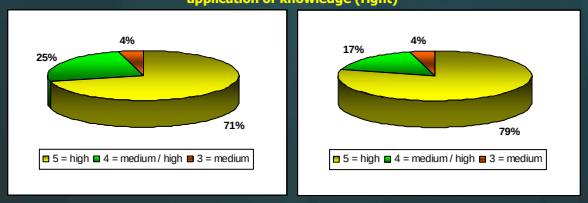

Fig. 4 Rates for the benefits expected from the classroom when using VIs related to: increasing the Science didactics awareness (left) and challenging for improving the teaching behaviour (right)

4. Conclusion

The traditional teaching methodologies and didactic strategies used for Science area teaching and learning can be easier interlaced with those oriented on ICT. In this way, the efficiency and benefits of virtual experiments and related software which allow the creation of virtual experiments by teachers themselves was clearly expressed by the in-service teachers who attended the "*Virtual Instrumentation in Science Education*" training modules organized in the frame of *VccSSe* project. As a general conclusion, the Romanian teachers emphasized their strong opinion that the introduction of the virtual experiments in the Science lessons was a real success besides the discovering of new channels for introducing ICT in their work with the view of helping the students to build their knowledge and to be creative in their learning.

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