A COMPARATIVE ANALYSIS ON USING SEVERAL VIRTUAL INSTRUMENTATION SOFTWARE IN EDUCATION

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Abstract: Using Virtual Experiments become one of the main methods for Science teaching in actual Education. Their power on creating simulation-based learning environments is well-known and many teachers have already adopted the virtual experiments to be used in their classrooms. The great extension of the Virtual experiments determined 9 institutions to propose a Socrates-Comenius 2.1. European project called *VccSSe - Virtual Community Collaborating Space for Science Education* project (code: 128989-CP-1-2006-1-RO-COMENIUS-C21) coordinated by Valahia University of Targoviste, Romania which has as main objective to adapt, develop, test, implement and disseminate training modules, teaching methodologies and pedagogical strategies based on the use of Virtual Instruments, with the view to their implementation in the classrooms. In the first year of the project, three software products were chosen for developing the process of training: *Cabri Geometry II*, *LabVIEW* and *Crocodile Clips*. This paper presents the results of a comparative analysis, made by the tutors who trained the in-serviced teachers on using the mentioned software products.

1 INTRODUCTION

In general, setting up demonstrational experiments needs time and effort. These setups must be tested and reset before they are displayed. Real experiments may also require technique expertise and a lot of work. A modern solution implies the use of virtual instrumentation in the teachers' demonstration experiments. Virtual instruments are in fact software applications which, concerning their functions and appearance, imitate real or realistic instruments or equipment (Kántor and Gingl, 2002). From an educational point of view, Virtual Experiments support students to learn scientific phenomena and concepts. The responses of the learning processes that involved Virtual Experiments have demonstrated that the virtual environments can be used as a useful methodology in Science education for school students (Shin, 2003).

In this sense, in the last period, several European projects targeted on promoting Virtual Experiments in Education. Lab developing training systems which integrate virtual experimentation and intelligent tutoring technologies become usual subjects. Beside previous projects, *VccSSe* project is addressed - on the one hand - to in-service teachers training on using virtual instruments (VIs) in the teaching process of different Science disciplines (Mathematics, Physics, Chemistry) and - on the other hand - to the pupils (as end-users) who benefit by the implementation of the Virtual Experiments in the classrooms. In addition, the project partnership assumes to build pedagogical approaches in a virtual space (*VccSSe e-Space*) able to offer efficient ways of using specific tools for logical understanding of the fundamental concepts in Sciences.

2 VIRTUAL INSTRUMENTATION ENVIRONMENTS

In the frame of the above mentioned *VccSSe* project (http://www.vccsse.ssai.valahia.ro), the partnership

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composed by 9 educational institutions from Romania, Spain, Poland, Finland and Greece, prepared and developed specific materials for training on using *Virtual Instrumentation in Science Education*. The training materials were designed to in-service teachers from primary and secondary schools involved in Sciences subjects in the partners' countries. As a decision of the project staff, the training materials presented three Virtual Instrumentation environments (*LabView*, *Crocodile Clips* and *Cabri Geometry*) (Gorghiu (coord.), 2007) and the participants were asked to select one of the software environments for understanding its main functions and creating at least one learning object that has to include a virtual application.

In order to give more help to the course participants in the selection of the Virtual Instrumentation environment to use, it was provided a set of already made simulation-based virtual instruments, organized by area and category. This set of VIs is on-line provided in the VccSSe e-Space, integrated in the project web site, special designed to support the teachers' activities. The main science areas are: Mathematics, Physics, Chemistry and Digital Electronics.

Through e-Space, the partnership aims to offer examples of virtual instruments (free accessible by any web site visitor) which can be used to teach a wide range of science lessons. The VI examples aims to: (a) give a better understanding of VI environments, (b) provide an idea of what topics can be better taught using VIs (c) and help teachers to create the final products.

The training sessions were provided using the *Moodle* (*Modular Object-Oriented Dynamic Learning Environment*) e-learning platform. When necessary, special face-to-face learning sessions were held for given supplementary explanations and presentation. Hereinafter are presented several considerations regarding the software products used for training (Suduc et al., 2008).

2.1 LabVIEW

LabVIEW software was the first option for training activities. It is an intuitive graphical programming language with built-in functionality for simulation, data acquisition, instrument control, measurement analysis, and data presentation. This software is suitable for creating a wide range of applications in different areas of industries but also in education for Science subjects teaching.

From the student's point of view, *LabVIEW* has many advantages. The first one is the intuitive graphical interface that allows using the "drag and drop" technique to create specific user interfaces for the applications with pre-built objects. The application functionality can be specified by assembling block diagrams. The intuitive graphical nature of *LabVIEW* allows students to focus on the theory being taught and not on the tool manipulation and on the programming nuances. The time to develop complex applications is shorter than using a general programming language. Because *LabView* is specifically design for engineers and scientists, and it is used in a wide range of areas, the students' transition from school to industry is smoother.

From the teacher's point of view, the additional materials provided by National Instruments represent a real help in curriculum developing. The Measurement & Automation Experiments Library contains experiments written by educators that show the use of National Instruments products in academic labs around the world. The Courseware is a collection of related experiments that encompasses an entire course or topic. Every experiment and courseware is free to download, ready-to-use, easy-to-modify.

Another *LabVIEW* advantage is offered by the possibility to remotely control the applications, facility that opens a new window in the technical distance teaching.

All these benefits with the very unique software licensing give the possibility to improve the face-to-face and distance education.

2.2 Crocodile Clips

Other two environments were proposed by the partners to be used in training: *Crocodile Clips* and *Cabri Geometry II Plus*. The new tools were proposed as alternatives which can fit their necessities for being suitable with the national curricula.

The *Crocodile Clips* simulation packages are developed specifically for education and allow students and teachers to recreate experiments, model mathematical theories or simulate real life quickly and easy. *Crocodile* simulators let students experiment in a safe, accurate environment, and come with a wealth of ready-made simulations and models. *Crocodile Clips* includes four packages: *Crocodile Physics*, *Crocodile Chemistry*, *Crocodile ICT* and *Crocodile Mathematics*. In the frame of the *VccSSe* project, the first two packages were selected.

The main *Crocodile Clips* advantages are related to the user-friendly interface and curricula focus features for the primary and secondary school. In order to easily learn how to use these tools, the *Crocodile Clips* developers provide many useful free training videos.

2.3 Cabri Geometry II Plus

The mathematics teachers had also the opportunity to use the *Cabri Geometry II Plus* software environment. *Cabri* allows the dynamically exploration of Euclidian, transformational and coordinate geometry. It makes the math's concepts easier to learn thanks to its kinesthetic learning approach. It is easy to create a geometric figure, an equation or graph a function on the *Cabri* screen - which comes alive as a manageable object. *Cabri Geometry II Plus* is an environment recognized by experts in pedagogy, specifically for its simplicity of use and solid educational foundation.

3 METHOD

After the end of the *Virtual Instrumentation in Science Education* course development and its first edition, the chosen software environments were evaluated, taking into consideration the following ten criteria: (1) usability, (2) collaboration, (3) active learning, (4) expression of students' knowledge, (5) holistic approaches in learning, (6) interesting activities, (7) promoting pupils' reflection, (8) providing appropriate feedback, (9) designing various activities and (10) concept / content teacher. The whole analysis was made based on a questionnaire with 10 questions related to the criteria mentioned above. The questionnaire was filled by the course tutors and covered the partners' institutions which participated in the project. 31 tutors, with technical and pedagogical background, filled in the questionnaire. The tutors have been asked to choose one of the five answers: *Not good*, *Weak*, *Middle*, *Good*, *Very good* for all the criteria. The answers were collected and processed with the view to evaluate the Virtual Environments software and to take decisions regarding eventual needed modifications for the second edition of the course.

4 RESULTS

Assuming the percentage as a ratio of the *Very Good* answers (over 50% of them - for a given criteria), the strengths of the respective software can be stated. On the other hand, the ratio of the weaknesses was evaluated as more than 25% of the negative answers (*Middle*, *Weak*, *Not good*) for a given criteria. Having in view those remarks, concluded information tables (*strengths / weaknesses*) can be expressed.

Table 1: Final image of the *strengths* analysis.

Software product	Strengths
Cabri Geometry	usability, active learning, promoting pupils' reflection*, providing appropriate feedback*, designing various activities*
LabVIEW	active learning, interesting activities, promoting pupils' reflection, providing appropriate feedback*, designing various activities
Crocodile Clips	active learning**, concept/content teacher**

Observations can be emphasized also concerning the opinions with major differences (*) and the criteria which have the biggest percentage of *Very good* answers, but nevertheless, they are not predominant (**).

Table 2: Final image of the *weaknesses* analysis.

Software product	Weaknesses
Cabri Geometry	designing various activities
LabVIEW	holistic approaches in learning
Crocodile Clips	collaboration, promoting pupils' reflection, providing appropriate feedback, designing various activities, concept/content teacher

Using the ratio mentioned above, the software which stands out with respect to the required criteria is indicated in Table 3 and Figure 1.

A general result can be drawn on the basis of the overall evaluation of the software. *Cabri Geometry* has a global appreciation rated at 92%, *LabVIEW* at 85% and *Crocodile Clips* at 72%.

The very good appreciation of *Cabri Geometry* environment is not a big surprise as it provides a real opportunity to approach a variety of subjects concerning Euclidean Geometry. We think that its great usability, the possibility for providing a real active learning and an appropriate feed-back brought it very near of both Mathematics teachers and students.

Table 3: Result of the standing out for each criteria.

Criteria	Software
usability (1)	*Cabri Geometry* (A) 71%
collaboration (2)	*Cabri Geometry* (A) 29%
active learning (3)	*Cabri Geometry* (A) 57%
expression of students' knowledge (4)	*LabVIEW* (B) 33%
holistic approaches in learning (5)	*Cabri Geometry* (A) 29%
interesting activities (6)	*LabVIEW* (B) 56%
promoting pupils' reflection (7)	*LabVIEW* (B) 89%
providing appropriate feedback (8)	*Cabri Geometry* (A) 72%
designing various activities (9)	*LabVIEW* (B) 67%
concept/content teacher (10)	*LabVIEW* (B) 33%

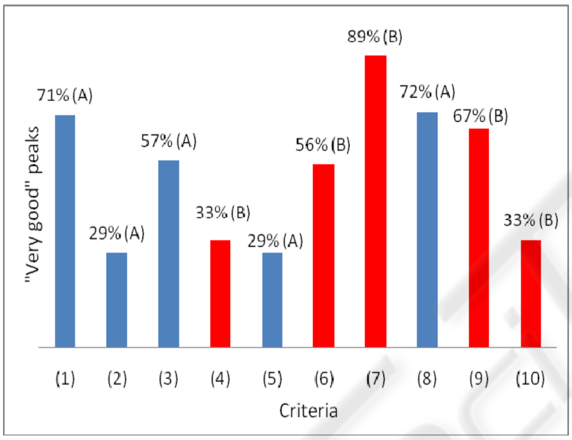

Figure 1: Criteria – "Very good" peaks representation.

LabVIEW also presented strong educational features and good feed-back on expressing of the students' knowledge, designing interesting and various activities, promoting pupils' reflection or expressing a powerful concept / content teacher. More, the teachers and students (even they are acting in lower secondary education) can change the point of interest on the graphical user interface and programming language. In this direction, *LabVIEW* proposes a programming environment very good adapted to the easy designing of professionally interfaces or even real-time simulations of the experimental situations.

Finally, *Crocodile Clips*, despite of its large scale usability, was insufficient pointed to win a criteria. But, as this analyze is going to be repeated after the second edition of the *Virtual Instrumentation in Science Education* training modules, it is a chance to change the situation in a way. In addition, a free and multi-platform dynamic mathematics software (*GeoGebra*) will be included in a similar analysis. As *GeoGebra* has received several international educational software awards, it is possible to refine some of the results given here.

5 CONCLUSIONS

Virtual Instruments are interactive tools with a tremendous potential to make an immense difference in education. The enthusiasm manifested by the in-service teachers trained in the frame of the *VccSSe* project and the pupils' positive feedback proves the project main objective accomplishment.

The results of the comparative study do not reflect the real weaknesses and strengths of the software presented above. The results are reflecting only the tutors and local coordinators perception on these software features and their applicability in the frame of the *VccSSe* project.

The study planned after the second edition of the teacher training course will provide a more real image on these environments due to the experience gained by the tutors in the previous edition.

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