



Chapter III

Virtual Instrumentation existing options and VI selection criteria.

Lessons learned in VccSSe project

III.1. Educational Software as a Very Important Element of the Learning Context

The effect of context on students' actions and also on the solution strategies they adopt for the given problems is acknowledged in the learning of all science subjects (Noss and Hoyles, 1992; Kordaki and Potari, 1998; Laborde, 1993).

Noss and Hoyles (1992) have suggested that the educational context is comprised of the educational software, the student, the teacher, the interactions between teacher and students and the activity that students are presented with. These researchers have also stressed the importance of investigation into the effect of educational software as the "very medium" that can play a central catholic and penetrating role in the process of learning. The learning approaches developed by students acting in a context including educational software appear to be influenced by this context. Interaction with this computer environment focuses the students on the main points of the learning concepts and helps them to clarify the relations among the concepts included in this environment. Moreover, the standardization of relations among the concepts required in the formation of a computer learning environment catalytically affects the development of student strategies.

From another point of view, the computer environment gives students the chance to shape relations between formal and informal science and to make generalizations through specific cases. These researchers have also argued that the computer environment can play a "scaffolding" role and support the development of science activity. Borba and Confrey (1996) speak of the formation of a two-way relationship between the student and the educational



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software designer via the mediation of software in the actions of the former and the enhancement of the possibilities of the software by the latter.

III.2. Existing Options and VI selection criteria. Lessons learned in VccSSe project

The educational software market offers a large variety of virtual tools and applications that proved useful in meaningful Science teaching and learning. It is obvious though that these offers differ according to the science field they may be applied in, to the tools and instruments they comprise, to the action possibilities, interactivity, type and quality of feedback offered, possibilities for developing certain learning situations, price and availability.

One of the First Year Project tasks was to evaluate / compare the three kinds of software chosen for developing the process of training inside the Training Modules. Based on the partners experience in designing and developing virtual experience, the following software packages were selected: *Cabri Geometry II*, *LabVIEW*, *Crocodile Clips*. As the Project WorkPlan has foreseen in the first year the realisation of a comparative study on the previous mentioned VI environments, the partnership agreed to work on this important aspect having in view two important points of view: *pedagogical* and *technical*.

In order to process the needed data, a questionnaire designed by the Patras team has been conducted among the local coordinators and the course tutors. The Questionnaire proposed 10 criteria which are detailed below. The interviewee was to choose one of the five answers: *Not good*, *Weak*, *Middle*, *Good*, *Very good* for all the criteria. The answers were collected and the Bielsko-Biala team together with the Targoviste team elaborated this Comparative Study.

The evaluation of the software was done with the respect to the following criteria that the partnership considered relevant for the process of decision in selection of VI tools:

1. Usability
2. Collaboration
3. Active learning
4. Expression of students' knowledge



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5. Holistic approaches to learning
6. Interesting activities
7. Promoting students’ reflection
8. Providing appropriate feedback
9. Designing of various activities
10. Concept / content teaching

The results of the evaluation are presented in terms of strengths and weaknesses for each of the software used:

	Strengths	Weaknesses
Cabri Geometry	usability, active learning, promoting pupils’ reflection*, providing appropriate feedback*, designing various activities*	designing various activities
LabVIEW	active learning, interesting activities, promoting pupils’ reflection, providing appropriate feedback*, designing various activities	holistic approaches in learning
Crocodile Clips	active learning**, concept/content teacher**	collaboration, promoting pupils’ reflection, providing appropriate feedback, designing various activities, concept/content teacher

(*) a big opinion differentiation

(**) those criteria have the biggest percentage of “*Very good*” answers, nevertheless they are not predominant

Software which stands out with respect to the following aspects can be indicated:

Criteria	Software
usability	Cabri Geometry II
collaboration	Cabri Geometry II
active learning	Cabri Geometry II



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expression of students' knowledge	LabVIEW
holistic approaches in learning	Cabri Geometry II
interesting activities	LabVIEW
promoting pupils' reflection	LabVIEW
providing appropriate feedback	Cabri Geometry II
designing various activities	LabVIEW
concept/content teacher	LabVIEW

Summing up: out of the software presented, most appreciated are *Cabri Geometry* and *LabVIEW*. *Crocodile Clips* takes the third position.

A similar conclusion can be drawn on the basis of the overall evaluation of the software. It is favorable: ‘*Good*’ answers dominate (46%) as well as ‘*Very good*’ answers (34%), few (about 2%) are less than ‘*Middle*’ and concern *Crocodile Clips*. In the overall evaluation, *Cabri Geometry* with 92% takes the first place, *LabVIEW* with its 85% takes the second place and *Crocodile Clips* with its 72% takes the third place.

After the VI software evaluation and the tutors signalization of some *Crocodile Clips* problems it was decided to select, for the second edition of the *Virtual Instrumentation in Science Education* course, two new different software materials - freeware both of them -: *GeoGebra* (mainly oriented to Algebra and some parts of Physics), and *Models Creator* (only oriented to Physics). Because the VI software evaluation was favorable to *Cabri Geometry* and *LabVIEW*, these software will still be used also for the second edition of the Training Module sessions.

In pointing out the strong and weak points of the software that come out from the second edition of the course, the percentage gauge of the respective marks has been adopted here. Those criteria that got 50% and above of the “*Very Good*” marks are considered as strong points; on the other hand, the criteria that got more than 25% of “*Middle*”, “*Weak*” and “*Not Good*” marks are considered as weak points.



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In order to make the overall evaluation of the software, the descriptive gauge has been replaced by numerical one according to the following: *Not good* - 0, *Weak* - 1, *Middle* - 2, *Good* - 3, *Very good* - 4.

In the overall evaluation, *Crocodile Clips* got the highest score by about 0.1 point than the other types of software but the score of which is almost the same.

Software	Strong points	Weak points	Overall score
Cabri Geometry	active learning, promoting pupils’ reflection, providing appropriate feedback	collaboration, designing various activities	3.26
LabVIEW	active learning, expression of students’ knowledge, interesting activities*, providing appropriate feedback*, designing various activities, concept/content teacher	usability, collaboration, interesting activities*, providing appropriate feedback *	3.25
Crocodile Clips	active learning, concept/content teacher, interesting activities, promoting pupils’ reflection, providing appropriate feedback, concept/content teacher	collaboration	3.34
GeoGebra	usability, active learning	collaboration, providing appropriate feedback	3.25

(*) criterion chosen as a both strong and weak point

Using the same gauge, i.e. the percentage of the “*Very Good*” marks (in a given criterion, a software application got the highest percentage of “*Very Good*” answers/marks) the software that was evaluated as better in respective aspects can be pointed out:



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Criteria	Software (according to descriptive marking)	Software (according to numerical marking)
usability	GeoGebra (50%)	GeoGebra (3.41)
collaboration	LabVIEW (21%)	LabVIEW (2.84)
active learning	Cabri Geometry (74%)	Cabri Geometry (3.70)
expression of students' knowledge	LabVIEW (58%)	LabVIEW (3.32)
holistic approaches in learning	Cabri Geometry, Crocodile Clips (43%)	Crocodile Clips (3.43)
interesting activities	Crocodile Clips (70%)	Crocodile Clips (3.61)
promoting pupils' reflection	Cabri Geometry, Crocodile Clips (52%)	Crocodile Clips (3.47)
providing appropriate feedback	LabVIEW (53%)	Cabri Geometry (3.26)
designing various activities	LabVIEW (58%)	LabVIEW (3.37)
concept/content teacher	LabVIEW (58%)	Crocodile Clips (3.57)

Summing up: *LabVIEW* was the software application that got the highest score, because it was chosen in five criteria. The next ones are *Cabri Geometry* and *Crocodile Clips* (chosen three times). *GeoGebra* got the highest score for usability. Taking as a gauge the average score/rating of the chosen software (the software that got the highest score for a given criterion), *Crocodile Clips* was the most frequently chosen (4 times), then *LabVIEW* (3 times), the third one was *Cabri Geometry* (2 times) and the last one was *GeoGebra* (once only). In the case of both of the ways of evaluation the scores are almost identical.

For the overall evaluation of the software numerical scale was adopted. The differences among the scores are rather small (about 0.1), but nevertheless, *Crocodile Clips* got the highest score whereas the others with identical score were behind it.

In the evaluation of the criteria fulfillment/observation, numerical scale was adopted. The differences here are considerable (about 0.9).



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	Criterion	Score
1.	Usability	3.17
2.	Collaboration,	2.75
3.	Active learning,	3.67
4.	Expression of students’ knowledge,	3.20
5.	Holistic approaches in learning,	3.31
6.	Interesting activities,	3.43
7.	Promoting pupils’ reflection,	3.39
8.	Providing appropriate feedback,	3.15
9.	Designing various activities,	3.22
10.	Concept/content teacher	3.47

As far as criteria are concerned “active learning” got the highest score, then “concept/content teacher” and “interesting activities”, whereas “usability” and “providing appropriate feedback” got lower score; “collaboration” got the lowest score. None of the criteria got “*Not Good*”. Similarly, “*Weak*” rarely occurred (0% - 11%).

All the average scores of the numerical criteria (except “collaboration”) as well as the software are placed between “*Good*” and “*Very Good*” on the descriptive scale. That means that the software can be regarded as good and useful for the didactic process.

III.3. Criteria for effective design of lesson plans using VIs

The software products tested and explored during the project offer a large variety of options that may be used for introducing and analyzing Sciences contents in the classroom. Consequently, a virtual educational application receives a certain formative power in a specific pedagogical context. In itself, the virtual application has a limited formative meaning. Doubled by a problematic context, a set of heuristic questions, a series of discovery steps or instructions, the virtual ‘learning object’ receives specific formative roles and significances.



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The experience gained during the creation of training materials and in guiding teachers in the process of creating learning situations based on virtual applications proved that the selected software serve best for developing a number of specific learning settings:

- demonstrations in Geometry, Physics and Chemistry

Demonstration based on intuitive stimuli support logic understanding of abstract concepts, functions, relations and processes

- investigation and discovery based learning situations

Possibilities of variables manipulation included in all the software explored, doubled by heuristic questions and instructions create a favorable environment for deductions, generalization, conceptualization, formulation of laws and theories.

- problems

Problems may be organized around concrete, contextualized data. Possibilities included in all software for creating and using mathematical calculation charts while manipulating variables of the problem supports understanding of relations between variables.

- repetitive exercises that lead to knowledge transfer

By requiring students to modulate variables of a situation, repetitive exercising can be created, situations that support generalization and transfer of knowledge.

- explanatory situations

Explanations are supported by intuitive stimuli, thus students understanding of abstract processes being enhanced. Visual stimuli offer anchors for retrieval of knowledge and relations.

- evaluative situations

Specific knowledge consolidation situations may include evaluative questions that require deductions which prove understanding of mechanisms or relations between variables.

Each of the above learning situations may be fitted in different types of lessons selected according with one or more of the following criteria:

- type of learning teachers wish to support,
 - type of contents to be delivered,
 - curriculum requirements in terms of capabilities, values and attitudes
 - teaching style
-



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- students expertise
- teacher computer expertise

The analysis of the lessons and VI applications developed by the teachers show that they covered a limited typology of lessons to include the created virtual applications:

- lessons for delivery of new knowledge and skills based on previous life experience
- lessons for delivery of new knowledge and skills based on previous knowledge
- consolidation of knowledge lessons (most of the applications)
- evaluation lessons

Analysis of an example:

In order to illustrate the ideas mentioned above we will analyze from the pedagogical perspective one of the applications created with *Cabri Geometry II*:

Heights of triangle

File – New

- **Construct a triangle.** (Key 3 - Triangle). Click on three points on the screen that define the vertices of the triangle.
- **Name the vertices of the constructed triangle as A, B, C.** (Key 10 - Label). Click on each vertex of ABC and, in the shown frame, press A, B, C, on the keyboard.
- **Construct perpendicular lines from each vertex to the opposite side.** (Key 5 - Perpendicular line). Click on vertex A and then on side BC. Use the same procedure to construct the other perpendicular lines.
- **Construct the intersection points between perpendicular lines and the sides of ABC.** (Key 2 - Intersection point). Click on a side of ABC and then on the corresponding perpendicular line.
- **Name D, E, F the intersection points.** (Key 10 - Label). Click on each intersection point and, in the shown frame, press D, E, F on the keyboard.
- **Color the triangle ABC.** (Key 11 - Fill). Select color, move the cursor toward one of the sides of the said triangle and click.



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- **Move the vertices of the triangle ABC.** (Key 1 - Pointer). Click and hold on each vertex of this triangle and drag the cursor on the screen.

In the situation when students create the geometrical construction, they exercise the relationship between vertices of a triangle and heights of a triangle.

QUESTION 1: What do you observe?

- **Move the vertices of the triangle ABC.** (Key 1 - Pointer). Click and hold on each vertex of the triangle, while dragging the cursor on the screen.

QUESTIONS 2: In which type of triangle the heights are found inside it? In which type of triangle the heights are found outside it?

The question is meant for students to explore the relationship between heights of a triangle and types of angles of the triangle. Knowledge is to be transferred and explored in a new learning situation. This type of question can stand also as an evaluation question for concept of triangle height.

QUESTIONS 3: In which type of triangle the intersection point of its heights is inside it? In which type of triangle the intersection point of its heights is outside it? In which type of triangle the intersection point of its heights is just on one of its vertices?

Question 3 is a heuristic question that requires continuing the geometrical construction and observing the relations between type of triangle and heights intersection point.

III.4. Criteria for effective design of learning activities using VIs

Lessons may include a variety of learning activities provided that they are designed in order to:



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- Improve students' understanding of science contents
- Improve students' learning motivation
- Support correct application of knowledge
- Increase teachers' science didactics awareness
- Improve teachers' understanding regarding students' learning and motivation
- Challenges teacher to improve her teaching behavior.