Evaluation of Superconductivity Program

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Introduction

The Superconductivity Multimedia Educational Tool [1] were prepared in the Leonardo da Vinci Programme SUPERCOMET in 2002-2004 years [2]. Target group for this tool is the secondary school teachers of physics. This tool can facilitate not only the learning activities of pupils in schools but out-off activities of pupils, too. The Superconductivity Multimedia Educational Tool consists of the Teacher Guide, the multimedia Superconductivity CD, and the Superconductivity Demonstration Kits and Material. The aim of this Tool is integrating superconductivity into the curriculum in upper secondary schools in different countries. The multimedia Superconductivity CD was evaluated. The stress was given on active learning of pupils and how these materials facilitate the teacher preparation of pupils' activities. Constructivism, cooperative and collaborative learning, inquiry-based learning were the main content of questionnaires.

The electronic materials Superconductivity Multimedia Program on CD have translated into the languages of 15 countries and it is adapted to the systems of education of these countries in the Leonardo da Vinci Programme SUPERCOMET 2 in 2004-2006 years. There are many activities in SUPERCOMET 2 program. The evaluation of the Multimedia Superconductivity Program on CD was one of the first activities. The reason of the evaluation was improving the quality of the Superconductivity Multimedia Program. The results of this evaluation are given in this contribution.

There were two groups of evaluators - reviewers. The first evaluation was carried out by experts from different countries – Bulgaria, the Czech Republic, the Great Britain, Poland, Italy, and Belgium. The second one was carried out by teachers of partners' secondary schools from the Czech Republic.

The questionnaire for the first evaluation was prepared by Erika Mechlova (CZ), Nadezhda Nancheva (BG), Pervoletka Docheva (BG), Libor Koniček (CZ), and Vegard Engstrøm (NO) at the 3rd SC2 Meeting in Ostrava in April 2005 and it was corrected by Harvey Mellar (GB).

The questionnaire for the second evaluation was prepared by Erika Mechlová, Libor Koníček, and Petr Smycek (CZ).

The electronic program Superconductivity consists of six modules. The list of developed modules is as follows:

1. Magnetism of wires and magnets
2. Magnetism of coils and materials
3. Electromagnetic induction
4. Electric conduction
5. Introduction to superconductivity

6. History of superconductivity

1. Evaluation of Superconductivity CD by the international experts

The group of international reviewers consisted of professor in physics education, professor in physics, senior lecturer in physics education, professor in experimental physics, senior lecturer in educational computing, physics teacher secondary education, teacher trainer and coach.

The electronic material on Superconductivity CD were evaluated from the point of view

1. Technical aspects of the computer applications
2. Scientific aspects of the computer applications
3. Pedagogical aspects of the computer applications

The results of these evaluations are 27 pages of recommendations that are on website of Leonardo da Vinci programme for all members of team that come from 15 countries. The short conclusions of these recommendations are given in this article because of to avoid these matters in future.

1.1 Technical aspects of the Superconductivity CD computer applications

The Superconductivity multimedia program on CD operates on MS Windows XP and MS Windows 2000. Browsers that were used without any complication were MS Internet Explorer, Mozilla, and Netscape. There were any technical difficulties with starting up and using the applications. All characters were displayed correctly on screens including Greek alphabet and exponents.
Hotkeys for navigation were not implemented in the evaluated version of program; navigation was done by mouse clicks. The opinions of the international experts were different, they prefer both type of navigations.
The numbers of pages are missing, it has to be improved.
The "BACK" in inner parts of modules is missing, it has to be improved.

1.2 Scientific aspects of the Superconductivity CD computer applications

The questionnaire had three parts as concern scientific aspects:

a) Scientific errors in the animations and suggested improvements
b) Scientific errors in the text explaining the animations and suggested improvements
c) Correspondence of the scientific content of animations and texts with the stated prerequisites and learning objectives in the Teacher Guide

Every six modules were evaluated from above stated points of views. Results are as follows:

Scientific errors in the animations in modules from 1 to 6 take in different running of real experiment and animation. Animations don't correspond to real experiments especially as concern following phases of experiments and duration of these phases. Preparation of animation is suggested through model: real experiment – phases of real experiment – model of real experiment – animation.

Scientific errors in the text explaining the animations in modules from 1 to 6 take in microscopic explanation of Ohm's law, explanation of Cooper pairs, incorrect names of physicists, using vectors in place of scalars and vice versa, labelling of axes incorrect way

only by units of quantities in place of quantities and units, one axes with scale and the second one without scale.

Correspondence of the scientific content of animations and texts with the stated prerequisites and learning objectives in the Teacher Guide are good. There were only a few remarks.

Expert's recommendations:
The modules from 1 to 4 are structured in the same way and they are complete. The modules 5 and 6 are not complete at all. There is no systematic approach to the different items in these modules. Especially module 6 "History of superconductivity" is not suitable for the secondary schools – recommendation to remake it.
Use systematically the *ISO-31* and especially *ISO-31-11* Mathematical signs and symbols for use in the physical sciences and technology [3] as concern terminology, types of characters, legend on axes.

1.3 Pedagogical aspects of the Superconductivity CD computer applications

Based on work with the SUPERCOMET material, more advanced pupils shall be able to [1; 10]:

1. Argue how a theory is related to evidence
2. Explore actively possible uses of phenomena
3. Explore actively technological implications of a new discovery
4. Describe how scientists gain and interpret data
5. Describe how science and technology uses new ideas
6. Communicate scientific ideas to different audiences
7. Ask questions to themselves about physics and how it is related to everyday life
8. List some connections between different fields of physics

Achieving of overall aims and learning objectives are realistic only for the most advanced pupils.

Animations and text correspond with the stated prerequisites and learning objectives. Recommendation is to add some movies from real experiments.
Organisation of content inside each module is good. There are only a few recommendations for module 5 and remake module 6.
Experts recommended *new module* in he next version as concern quantum phenomena and some experiments in "tips" or "SEE MORE".
The others pedagogical suggestions for the next version of the computer application are as follows:

- Only further explore modelling and development of simulations rather than animations
- Make stop-picture easily possible.

2. Evaluation of Superconductivity CD by the secondary school teachers

The Czech teachers of the partners' secondary schools filled up questionnaires. They gave points from 6 to zero to the questions, the best quality was 6 points, and the worst quality was zero points. They gave the appreciations in a few items of questionnaires. Results are given in tables as follows.

2.1 Evaluation of the technical aspects of Superconductivity CD

The teachers had to give points from the best 6 to the worst zero.

Table 1: Technical aspects of Superconductivity CD

Questions Give points from the best 6 to the worst 0	**Points**
Is the interface intuitive?	4.5
Is the material well systematized?	5.0
Is navigation clear?	5.0
Is the resource technically stable?	5.5
What is your opinion about quality of the animations?	6.0

The animations were regarded as the best, the resource was technically stable. The interface wasn't intuitive – it has to be improved.

2.2 Evaluation of physics content on Superconductivity CD

Table 2: Physics content of Superconductivity CD modules

Module	**Appreciations**
1 Magnetism of coils and materials: Are the aims of module clearly formulated?	Good module, more universal point of view is missing
2 Electromagnetic induction: Are the aims of module clearly formulated?	Good module, more universal point of view is missing, formulas are missing
3 Electric conduction: Are the aims of module clearly formulated?	Very good module, errors – Ohm's law, labelling of axes by units, graphic representations of physics functions $y = f(x)$
4 Magnetism of wires and magnets: Are the aims of module clearly formulated?	Very good module, formulas are missing
5 Introduction to superconductivity: Are the aims of module clearly formulated?	The best module, questions are difficult without previous modules
6 History of superconductivity: Are the aims of module clearly formulated?	Module is focused theoretically

Table 3: Properties of physics content of Superconductivity CD

Questions Give points from the best 6 to the worst 0	**Points**
Is the content accurate?	4.75
Is the content up-to-day?	6.00
Is the content objective?	5.50
Is the content reasonably comprehensive?	4.25
Does the content making clear its bias?	5.00
Is the content relevant for learner?	5.00
Does the content appropriate vocabulary?	5.50
Are the animations presenting the physics content clearly?	6.00
Is the text for the simulations clear?	5.00
What is your opinion about quality of the animations?	6.00

From the point of view the Czech teachers the best module is “Introduction to superconductivity”. The modules “Magnetism of coils and materials” and “Electromagnetic induction” have a lack of more universal point of view. The worst module from the point of view teachers is “History of superconductivity.

2.3 Evaluation of content on Superconductivity CD from the pedagogical view

Table 4: Pedagogical rate of Superconductivity CD content

Questions Give points from the best 6 to the worst 0	**Points**
Is it clearly formulated addressee of program?	5.25
Are the aims of program clearly formulated?	4.75
Is the structure of program clear?	5.50
Do the resources provide support?	5.25
Do the resources give feedback?	4.50
Do the resources give the enhancing collaborative learning by encouraging learners to discuss problems?	5.00
Do the resources share information and ideas and group agreement?	4.75
Are the animations present clearly the studied effects and phenomena?	5.75
Will the animations help students to create mental images of studied effects and phenomena?	6.00
Is the text to the animations clear?	5.50
Do the simulations provoke student’s interest in physics?	5.75

The evaluation of physics content is positive. The accuracy of physics content has lower level. The Czech secondary school teachers are familiar with the texbooks where the statements are very exact.

Conclusions

The evaluation of Superconductivity on CD is very useful for enhancing of learning effectiveness for the target group and for eliminations of all errors - obscure texts, incorrect statements, curious pictures, animations, simulations, videos, etc. The first evaluations of SUPERCOMET CD ROM were made by experts from different countries. These experts were specialists in physics, physics education, and computer science. The second evaluations of SUPERCOMET CD ROM were made by experts – the partners’ secondary schools teachers from the Czech Republic. The results both evaluations and recommendations were the same.

The third evaluations will be made by secondary school pupils. They are the final recipients of all superconductivity materials.

Leonardo da Vinci Programme yields very good experience in international co-operation. The evaluations serve for all countries - every country can receive the best material at the end of project. But the educational history and present educational policy are different, the country has own history and adaptation of materials for different countries is necessary.

References

[1] Earle A 2004 *Supercomet. Superconductivity Multimedia Educational Tool*. Trondheim: Richard Birkelands, 2004. 208p. ISBN 82-8130-045-0.

[2] Engstrøm V 2004 The SUPERCOMET Project - animation electricity and magnetism for upper secondary school *Teaching and Learning Physics in new Contexts.* University of Ostrava, 2004, p. 149-150. ISBN 80-7042-378-1.
[3] Mathematical signs and symbols for use in the physical sciences and technology 1999 Part 11 *ISO-31-11*