Instructional software supporting hands-on laboratory activities in physics education

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Abstract

Relevant researches have pointed out that interactive engagement allows students to construct and implement appropriate mental models of physical phenomena better than the lecture [1]. New curricula, impose an inquiry teaching approach using hands-on activities and experiments. An instructional software has been formed, based on cognitive theories [2], in order to support inquiry and cooperative hands-on laboratory exercises. It includes animated and videotaped experiments and concerns topics of classical physics such as: Newton's laws, Pressure in solids, Hydrostatic and air pressure, Heat and ways of transmission, Expansion in solids liquids and gases, Mechanic waves and Sound transmission, Optics and Electricity. An intervention is being developed the last academic year at five classes at the Pedagogical department of the University of Athens and two classes of the 6th Grade of Elementary school. First evaluation shows that computer assisted physics laboratory, supported by the specific software, affects positively the conduction of hands-on activities, supports conceptual learning, enforce an inquiry and cooperating teaching approach, and creates a positive attitude to the students involved towards hands-on laboratory activities [3].

Introduction

An inquiry teaching approach with the performance of hands-on activities and experiments with simple materials is suggested strongly by new curricula mainly in primary education. There is an effort the laboratory activities to be computer assisted supported by a suitable software, so that the teacher will be able to coordinate properly with the best conceptual results for the students [4].

1 The software

1.1 Characteristics

An instructional software has been designed in order to be used as a basis for the performance of an inquiry and cooperative hands-on laboratory teaching. It has been structured in the framework of scientific method [5], consisting of:

I) triggering images and articles,
ii) problem solving situations,
iii) specific instructions for performing step by step the experimental procedure,
iv) interpretation of the phenomena observed and
v) relevant topics for further study and discussion.

For more detailed guidance, each experimental instructions are accompanied by videotaped parts of the experiment, focusing on basic points for the conduction of the procedure. The result of the experiment is not displayed in these phase. The students are called to predict and reason their prediction before actually perform by themselves the experiments. Only after having performed the experiment [6][7], students can see the whole film, revising and highlighting the crucial points or performing it again, if necessary [8].

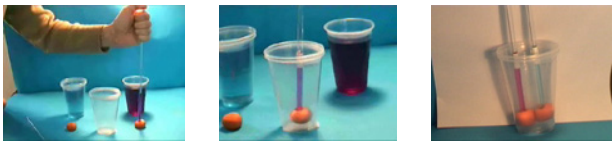

Figure 1. Selected frames of a videotaped experiment about liquid expansion.

For the evaluation of the intervention a pre and a post test are included for each section while a worksheet is given to be filled when experiments take place.
The software has been formed at the Microsoft Front Page application so that it can be web published and videotaped files have been edited at Animation Shop in order only useful frames to be presented.

1.2 The contents

The topics presented in the software are relevant to the ones the students/teachers are required to teach as a part of the Greek state elementary science curriculum [9]. These are: Newton's laws, Pressure in solids, Hydrostatic and air pressure, Heat and ways of transmission, Expansion in solids, liquids and gases, Mechanic waves and Sound transmission, Light reflection and refraction as well as Electric current.

2 The research

An intervention has been developed during the last academic year at 150 students/teachers who have attended five laboratory classes at the Pedagogical Department of the University of Athens.

The two classes have used the full version of the software including the animated and videotaped experiments through all the teaching procedure.

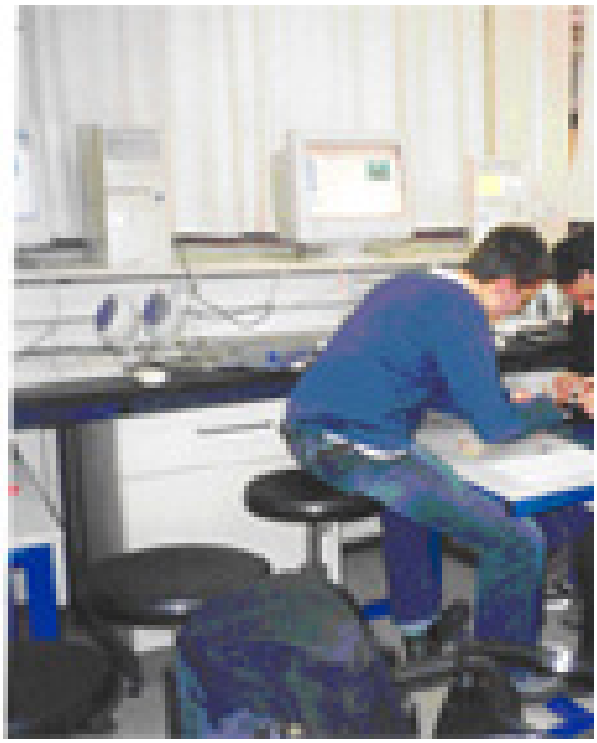

Figure 2. Students/teachers at the laboratory of the Pedagogical Department.

The other two classes have used a version of software with pictures instead of videos or animations in all phases apart from the final step, this of revising and drawing of conclusions. Finally, the fifth class has used printed notes and worksheets instead of software, following the same teaching procedure.

A similar intervention has been developed at two classes of the 6th Grade of Elementary school, too.

Figure 3. 6th grade students at school laboratory.

Multiple methods to assess the effectiveness of our approach have been used. The outcome measure we select for analysis include scores on questions related to topics covered before and after each instruction, exam grades and course grades as well as homework evaluation. Qualitative assessment is performed with the aid of observation tools and interviews.

Conclusions

First evaluation shows that computer assisted physics laboratory, supported by the full version of the specific software, enforces the cooperative characteristics of the teaching procedure as help students and teacher/students to conduct the experimental procedures with minimum of guidance by the supervisor instructor. The students attending the first intervention achieved also higher scores at final exams concerning topics related to the videotaped experiments and seemed to have developed a positive attitude towards hands-on laboratory activities.

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