

# **"Interaction Of Light And Matter"**

## **Development, Implementation And Evaluation Of New Curriculum Unit For High School Chemistry Students**

Thesis for the Degree  
DOCTOR of PHILOSOPHY

Submitted to the Scientific Council of  
The Weizmann Institute of Science  
Rehovot, Israel

By  
JACOB RONKIN

March, 1997

### **Abstract**

The project described here consisted of the development, implementation and evaluation of a new curricular unit named "interaction of Light and Matter". This unit is offered as an optional unit for high school students who major in chemistry. The subject matter of this unit is a combination of a discussion of the scientific principles of phenomena of interaction of light and matter that relevant to students' everyday life (such as, operation of microwave oven, fluorescent lamp, TV screen, etc.) and a presentation of scientific subjects. The scientific subjects were chosen from two types: partially they were traditional, standard subjects (such as, determination of molecular structure, identification of materials, etc.) and partially they belong to the field of modern research (such as, depletion of ozone layer).

To deal with all those phenomena unified framework was developed in the textbook. In discussions of scientific and technological applications their advantages and limitations were emphasized. Special chapter was devoted to the phenomena of interaction of light and matter in the atmosphere (the ozone layer depletion and the Greenhouse effect). In this discussion the open nature of scientific inquiry and the multidimensionality of "real" life problems were emphasized.

Besides the textbook other complimentary teaching aids were developed: scientific learning trip activity, computer software package and worksheets. Scientific learning trip was help at the Youth Activities Center at the Weizmann Institute of Science and the program was consisted of lectures, performing experiments, visiting scientific laboratories and working with computer software. In the focus of this program was the performance of

experiments that were done by small groups of students using modern research equipment. Software package consists of 3 different programs, the main usage was made with the program "ZoDo" (that was developed with collaboration with two students from high school in the name of Brener). This program uses dynamic animations that were created by different advance application programs in order to demonstrate variety of molecular motions on the level of single molecule.

Several teaching aids were developed: the teacher's Guide, the solution manual and the newspaper fragments collection. During the academic year 1994-1995 three in-service teacher training courses were performed. In these courses 80 high school chemistry teachers were prepared to teach the new unit. During two academic years (1994-1995 and 1995-1996) the unit "Interaction of Light and Matter" was implemented in 24 different classes.

Evaluation research had qualitative and quantitative components and it was performed in two stages. The first stage was performed during the academic year 1994-1995 when the new unit was implemented in 7 classes. At this stage evaluation study was more formative in nature aiming to evaluate the textbook and other learning aids that were developed. As a result of this study several types of misconceptions were found and classified. According to these findings two chapters of the textbook were rewritten and several other improvements were made. In addition, as a result of the valuation study several changes were introduced into the program of learning trips and the software "ZoDo". Improved version of all learning materials were prepared for implementation in the academic year 1995-1996.

In the academic year 1995-1996 the improved version of the new unit was implemented in 17 classes. At this stage the focus of the research was on evaluation of the quality of the changes and on more summative evaluation of the unit as a whole. The results of the research revealed that the new unit was implemented successfully and it integrated into the existing chemistry curriculum. The unit is appropriate to high school chemistry students in depth and in scope and arouse very much interest in the students. According to the findings this interest could be contributed to two factors: relevancy of the subject to the everyday life of the students on one hand and to the modern scientific research on the other hand. Usage of variety of instructional methods and materials (learning trip, computer software, etc.) also contributed to the interest and the achievements of the students. Students achievements in the final exam during the two academic years (1994-1995 and 1995-1996) were relatively high and in the accordance with their achievements on this part in the matriculation examination. Students attitudes toward chemistry and physics were changed significantly. The backgrounds of students that learned this unit was different (biological, physical and other) but due to diversity of subjects that are discussed each group of students found in this unit issues

interesting for them. Teachers expressed positive attitude to the unit and all teachers that taught this unit in the academic year 1994-1995 continued the teaching in the following academic year 1995-1996. Teachers got continuous support during the implementation, their questions and suggestions had quick responses and all those contributed to their satisfaction from the implementation of this unit in their classes. Several teachers initiated other activities (such as, using additional instructional strategies) that contributed to the successful implementation of the unit.

In view of research findings we recommend that additional curricular units that integrate everyday life subjects with modern scientific issues in chemistry should be developed and incorporated into the existing chemistry high school curriculum.