



Promotion of Lifelong Learning of Scientific Subjects:

Challenges, Opportunities and Strategies

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ABSTRACT

In this report, the current situation of science education is generally overviewed with special focus on chemistry teaching at all levels of education in Turkey. The initial part of the report comprises a brief analysis of the results of national and international student evaluation programmes and reports. Then, the latest reforms and developments concerning science education curriculum are discussed. In addition, various studies and researches on science education and especially chemistry education are reviewed, examined and evaluated. As a result of the evaluations of these researches, it is understood that students and adult learners have various misconceptions about science and chemistry. Moreover, it is also realized that constructivist approach has positive effects on learning concepts of science and chemistry.

1. Introduction

Most countries' science curriculum aim to have pupils obtain knowledge in order to understand the environment and develop a thinking system by the help of the science education given in primary level; so, it is generally tried to generate specialities in this manner such as:

- Developing a realistic and coherent worldview,
- Explaining the conceptual context of the science,
- Developing the necessary skills for the scientific method to be used,
- Complying with the new developments in science and technology,
- Raising productive people for the society (Gücüm & Kaptan, 1992).

The rapid growth in science and technology after World War - II, the examination of the data through various researches caused important innovations in science education. The achievement of the improvement in science and technology areas resulted in the revision of the subjects in the science books (Zengin, 1968). For this reason; the objectives of the education were discussed again; the occurrence of knowledge and the styles to teach them began to be emphasized (MEB, 1967).

The USA and some of the European countries; the organizations such as OECD (Organization for Economic Corporation and Development), Ford Foundation, NSF (National Science Foundation), TÜBİTAK (The

Scientific and Technological Research Council of Turkey) support new curriculums and new methods of instruction both by financially and by the seminars and conferences they have organized (Demirbaş, 2001). Turkey also followed closely the studies abroad for the science instruction and put the prepared science instruction curriculum into practise in primary and secondary levels. The program development studies held by Turkey were shaped according to the results of the international researches such as PISA, TIMSS.

2. Science Education in National and International Reports

In PISA 2006 research, that is the most comprehensive educational study ever done, the sufficiencies of the pupils were taken into consideration more than any others. In the technology-based societies of our time; the understanding of the basic scientific notions and theories, the configuration and solving skills of the scientific problems are important as never before. Despite this; there is an observable decline in the rate of the students studying science and technology in universities in the last 15 years in some of the OECD countries. There are various reasons of this. However; some studies claim about this subject that, not only because of natural and applied sciences and its curriculum, but also, the attitudes of the students towards natural and applied sciences might play an important role (PISA, 2006). PISA 2006, so; evaluates not only students' natural and applied sciences knowledge and skills and at the same time, students' attitudes towards natural and applied sciences and it evaluates whether or not, they are aware of the opportunities when they possess the scientific sufficiencies they gain in their schools.

PISA 2006 study, with its wide geographic and co-operative structure, includes 30 OECD member countries with 27 non-OECD member countries. PISA 2006 study was held in May of 2006. The study covers natural and applied sciences, mathematics and reading skills; and, in this study, natural and applied sciences were concentrated. Turkey participated in PISA 2006 with a total number of randomly selected 4942 pupils in 160 schools, who were classified according to the regions and their schools, from 7 geographical regions and 51 cities.

According to the PISA 2006 report, Turkey's science average is 424 points. There isn't any significant difference between science literacy average points of Bulgaria, Uruguay, Jordan, Thailand, Romania and Turkey. In addition turkey has performed better than Montenegro, Mexico, Indonesia, Argentina and Brazil. According to PISA 2006 competency levels, students in Turkey have the following competencies in the science field: they have sufficient scientific knowledge only enough to draw a conclusion based on simple researches, and they can make possible explanations in ordinary situations. They can make logical inferences and simple interpretations according to the results of scientific interrogation or technological problem solving.

As for Turkey's insufficiency has been proved by international achievement evaluations, Ministry of National Education has made significant changes in the science curriculum of primary schools. The name of "science curriculum" has been replaced by "science and technology curriculum".

In the preparation of the curriculum, various countries' science curriculums have been examined and Turkey's regions' geographical and physical infrastructure and facilities have been considered. Weekly hours of science and technology lesson have been increased to 4 from 3. In the curriculum of science and technology lesson, it has been aimed "to make all students science and technology literate whatever their

individual differences are". It is suggested that science and technology literate individuals will be more effective in reaching and using information, solving problems and producing new information. Seven dimensions have been identified for science and technology literacy (MNE, 2005):

- 1- Nature of science and technology,
- 2- Key concepts of science,
- 3- Scientific process skills,
- 4- Science-technology-society-environment relations,
- 5- Scientific and technical psychomotor skills,
- 6- Values that form the essence of science,
- 7- Attitudes and values concerning science.

In the science and technology curriculum, technology and science are examined as related to each other. The most important feature that distinguishes science and technology is that their aims are different. Science tries to explain the natural world by understanding it, while technology aims to make changes in the natural world in order to meet the desires and needs of human being.

Seven learning areas have been suggested in the basic structure of science and technology curriculum:

- 1- Life and existence
- 2- Matter
- 3- Physical events
- 4- Earth and universe
- 5- Science-technology-society-environment relations
- 6- Scientific process skills
- 7- Attitudes and values.

Ministry of National Education have been making "Quality Control and Case Study" researches at both national and international levels aiming at evaluating the education capacity since 1992. For this objective, Ministry of National Education participates in researches like "Students' Achievement Determination Examination (SADE)" at national level, and Programme for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS) at international level. In these researches, standard achievement tests and student, teacher and school inventories are applied. Data from these tests and inventories are used to identify students' acquisition degree of some basic skills and to identify the current situation of education system. Moreover, the current national situation can be examined by comparing the results with other countries' and comparisons at the international level are done.

Students' Achievement Determination Examination-2005 is a study which aims at determining the competency and achievement levels of students in the fields of *Turkish, Mathematics, Science and Technology* and *Social Sciences*. The study comprised of 153.462 students 4th, 5th, 6th, 7th and 8th classes of 829 public and private primary schools which were selected by random sampling from 81 cities of Turkey.

Although science points of students according to the results of SADE 2005 are 3 to 7 points higher than SADE 2002, this achievement is not the level which is desired or expected. The results of international PISA and TIMSS studies parallels with this national study, thus the need for more reforms and efforts at the all levels of Turkish education system is evident. It can be easily seen that MNE's recent efforts like renewing curriculum, developing coursebooks and materials, providing in-service training to teachers etc. are not sufficient in order to reach the desired achievement level. In addition, the results of these national and international studies imply not only MNE but also universities, publishers, NGOs and all civil society institutions should make further efforts.

At MNE, studies of quality control and situation determination in education are carried out by Department of Education Research and Development (EARGED). According to the results of Secondary School Entrance Examination and Student Selection Examination, implemented all over the country for the purpose of selection, and the results of Students' Achievement Determination Examination for the purpose of quality determination, it appears that education in Turkey is not of good quality that is expected, and the distribution of educational facilities in the country reflects some inequalities that are not desired.

According to PISA 2003 results, it is seen that learning and achievement level differences in science education in schools of our country reaches at high values oddly enough both within the schools and among the same kind of schools in the country. It is seen that teaching services cannot be presented with a similar quality to all of the students of the same school; additionally, the differences among the diverse schools of the same kind are so enormous with regard to the quality of teaching services that are provided. This unexpected situation, which is encountered especially at the end of compulsory education, shows that a standard could not be achieved both among the students who attend the same school and among schools that give the same certificate inland.

Results of Students' Achievement Determination Examination reveal that students allocate 1-2 hours or less for homeworks of science lesson. Most of the students at 6th, 7th and 8th grades like science lessons. Almost %80 of the students perceive themselves less successful or successful (ÖBSS, 2007).

3. A Review of the Researches and Studies on Science and Chemistry Teaching

The results of researches done at national level with regard to science teaching, including especially chemistry teaching are examined below.

Yalçın and Kılıç (2005) identified the students' misconceptions on the subject of radioactivity in their studies, they searched the efficiency of textbooks in development of these misconceptions. According to the research results, it is seen that the concepts such as radioactivity, radiation, radioactive substance are confused with one another. Examples regarding these terms are also given from textbooks.

Oskay, Erdem and Yılmaz (2009) examined the effect of laboratory studies on the attitudes towards chemistry. In addition, the relationship between the attitudes towards chemistry and the achievements were also examined. According to research results, it has been seen that the positive attitudes of the students who participate in laboratory studies towards chemistry are high.

In the study of Erdem, Yılmaz and Morgil (2001), Chemistry Achievement Test was applied to the students who study in science branches in order to examine the students' situation of comprehending the

basic concepts regarding chemistry lesson. The terms of mole-molecule, atomic mass-mass number, oxidizing agent-oxidized agent appeared in this test. It was seen that the students experience contradiction with the terms which were indicated in the research results.

Tezcan and Aslan (2007) examined the effects of laboratory method on high school students' comprehension of the solutions subject in their study. Test of Scientific Process Skills, Logical Thinking Test, Solutions Concept Test were applied as preliminary and post-test in the research. Ultimately, it was seen that the laboratory studies are more effective.

In the study of Demirelli (2003), it was seen that lesson activities which are carried out with constructivist approach have an effect on the improvement of students' interests, attitudes, creative thinking, problem solving, conceptual comprehension and practical skills with regards to chemistry.

Yücel, Seçken and Morgil (2001) stated in their studies that the students learn chemistry subjects by memorizing, and they use their practical knowledge while they answer close-ended questions. That's, it was stated that students appear in the learning environment without realizing the ways of getting data and what it serves for. It was also determined in the study that students' knowledge about basic symbols and units is insufficient.

Üce and Sarıçayır (2002) stated that students have many misconceptions according to the results of their study which used experimental method. They found misconceptions about mole concept, structure of the matter, chemical equations, acid-base, chemical equilibrium, solubility equilibrium, electrochemistry. For instance;

- Substances containing H^+ ion are acid, substances containing OH^- ion are basic.
- Concentration and intenseness of acid or base are the same things.
- Acid can contain OH^- ion.

For eliminating misconceptions, a study was carried out on freshmen of classroom teaching department and lessons were carried out with conceptual substitution texts and concept maps in experimental group; the lesson in the control group, however, were carried out with conventional method. It was seen that the method which was applied in experimental group is more efficient in the comprehension of scientific terms.

Nakiboğlu and Bülbül (2000) stated that the lesson activities that are performed based upon constructivist approach provide an increase in students' achievements. In addition, it was observed that students participate in experiments more willingly and their concern in the experiments increases when constructivist approach was used.

Yıldırım, Nakiboğlu and Sinan (2004) examined the pre-service teachers' misconceptions on the subject of diffusion in their study. As a result of their study, it was seen that they have substantial misconceptions.

Yıldırım and İlhan (2007) got the students' opinions about units. It was seen that students do not know the importance of units in general.

Akgün and Aydın (2009) examined the efficiency of constructivist approach on eliminating misconceptions on the subjects of melting and solution in their study. It was seen that the student teachers' misconceptions decrease when constructivist approach was applied.

In the study of Morgil, Seyhan and Seçken (2009), project-based laboratory applications were

applied to the students who are in the department of chemistry teaching. At the end of this process, changes in the students' scientific process skills and attitudes towards chemistry were observed.

In the study which was done by Ayas, Karamustafaoğlu, Sevim and Karamustafaoğlu (2002), the assessment of general chemistry laboratory was carried out in terms of student and instructor. According to research results, insufficiency of laboratory equipments and environment, the experiments' not being parallel with one another were shown as factors that cause learning disability to a great extent.

Çelikler, Güneş and Şendil (2006) examined the effect of constructivist approach on the success of freshmen who study in science teaching department for the subject of metals and nonmetals. In the result of the research, it was seen that there was an increase in the students' success.

When the studies are examined generally, it is seen that applications of constructivist approach, which include the basic logic in new science and technology curriculum, has an important effect in students' learning. Students' previous learning experiences are important in constructivist approach. Their having misconceptions, wrong previous knowledge will be effective in their future, lifelong learning activities.

For this purpose, the misconceptions of the students who study in Kırıkkale University, Faculty of Education, Department of Science Teaching will be determined first within the scope of basic terms, and their misconceptions will be tried to be eliminated with conceptual substitution texts, which are used for removing concept errors. Moreover, as a consequence of the studies carried out, the change of students' attitudes regarding chemistry will be measured and interpreted.

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