RECOMMENDATIONS TOWARDS DEVELOPING EDUCATIONAL STANDARDS TO IMPROVE SCIENCE EDUCATION IN TURKEY

Asist. Prof. Dr. Ömer Faruk KESER
ofkeser@yahoo.com
YYU, Faculty of Education, Department of Science Education, Van/TURKEY

ABSTRACT
Obtaining technological and scientific knowledge process change incredibly and rapidly in today's society as individuals continuously must construct and reconstruct their expertise in a process of lifelong learning. For this reason, scientific literacy is also of increasing importance in individuals' workplace. So, suggested approaches to promote the quality of human life by the educators should be adopted in the process of accomplishing these goals. In this respect, the United States is known to follow certain standards in the content of National Science Education Standards (NSES) project for all activities aimed at improving science education about fifteen years. This study investigated and presented basic features of the NSES project in terms of objectives, practices, and evaluation criteria. Consequently, some suggestions were made to acquire different approaches to educational research in developing countries such as Turkey.

Key words: Science Education Standards, NSES

INTRODUCTION

Nowadays, individuals feel an increasing need for reaching out and using scientific knowledge to keep up with changing conditions of the world and to direct their life considering faced and possible situation. The recent research point out that students are usually taught to solve well-structured problems in their classrooms despite the fact that most problems in everyday and professional practice are ill-structured (Jonassen, 2003). For this reason, students are generally unable to transfer problem solving skills that need to be applied to novel problems in different context. What a new world expect of individuals is not only a good command of relevant knowledge, but diversified social, communication and cooperation skills, ability to work in different contexts with experts from other fields, and ability to critically select, acquire, reproduce, and use knowledge. Therefore, these requirements pose considerable challenges to educational systems that are expected to produce experts for the world of the future, especially considered Turkey as a developing country.

Many studies have been performed to improve scientific literacy of people who are in formal education institutions and naturally affected by the progress. These studies have specifically aimed at solving the conceptual problems encountered in understanding scientific subjects. In examination of these studies, it is seen that majority of comprehensive projects such as Constructing Physics Understanding-*CPU*, Science, Technology, and Society-*STS* and Project 2061 have been developed in the United States (CPU, 2004; Bayraktar, Karamustafaoğlu, Keser, Yeşilyurt and Köse 2002; STS, 2004; Kesideu, 2001; P2061, 2004). One of the most important reasons for the above-stated projects was students' low level in science achievement at secondary level in the U.S. when compared to other countries. Although it was expected that the United States students would be the first in the world in science achievement by the year 2000, data from the Third/Trends International Mathematics and Science Study-*TIMSS* in 1995 and 1999 showed that the U.S. students were devastatingly far from this goal among participated countries (BITL, 2000; NRCR, 1998). Besides, The National Assessment of Educational Progress-*NAEP* reported the similar issues about science achievements of 4, 8, and 12 grade students in U.S. scale.

The US has focused on an educational reform movement with several projects since 1985 to investigate the reasons for the failure and to improve the existing status of science education (Bayraktar, Karamustafaoğlu, Keser et al. 2002). Project 2061, one of the most extensive developed projects to overcome this trouble situation, was introduced to larger populations with the reform proposal titled *Science for All Americans*, by which main factors affecting the formation of the skills and the knowledge which will bring success and meet the students' needs in the 21st century were determined (SFAA, 2004). The *Standards* apply to all students, regardless of age, gender, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science. Different students will achieve understanding in different ways, and different students will achieve different degrees of depth and breadth of understanding depending on interest, ability, and context. But all students can develop the knowledge and skills described in the Standards, even if some students go well beyond these levels (NSES, 2004). This was followed by *Benchmarks for Science Literacy*, a study emphasizing the need for integration of science, mathematics, and technology as well as reflecting the qualities that ought to be possessed by science literate people. Moreover, the *Benchmarks* specify how students should progress toward science literacy,

recommending what they should know and be able to do by the time they reach certain grade levels (BSL, 2004). The benchmarks of the study shaped NSES, were published National Research Council (NSES, 2004).

OBJECTIVES AND GENERAL SITUATION OF SCIENCE EDUCATION IN TURKEY

Most generally, objectives of education in Turkey have been determined with Five-Year Development Plans, the eighth of which is in practice from 2001 to 2005 (EFYDP, 2000). However, science curricula have included more concrete objectives about the needs for the future projections of Turkey in science education at the formal educational institutions.

The aim of the current science curricula in Turkey is similar to that of developed countries, but the fundamental implementation of it in many cases still suffer from inadequacies in the implementation process, such as poor teacher preparation, ineffective use of teaching and assessment methods, the lack of teaching aids, crowded classrooms, and regional issues at the school and district level that relate to opportunities for students to learn and opportunities for teachers to teach science. Besides, current science curricula are not much helpful for science teachers and students at the expected level (Ayas et al. 1993; Keser et al. 2003; Keser, 2004). Some of the recent research in Turkey showed that the most affecting factors of science education in today's classrooms were teachers, students, and parental characteristics, structure of course materials, initial teacher training-*ITT*, the use of learning/teaching techniques, structural properties of learning environments, and the entrance exams for schools respectively junior and senior high schools and universities (Keser, 2003; Keser and Akdeniz, 2002; Keser and Akdeniz, 2004). Despite all good intentions, Turkish students' learning of science is often too superficial. Students' grasp of science as a process of discovery, and of mathematics as a language of science reasoning, is often formulaic, fragile, or absent at all (Keser and Akdeniz, 2002). In fact, these are long-lasting problems in the Turkish context and other societies, particularly developing countries are also familiar with them. Therefore, it may be difficult to reach the stated curricular objectives. Actually, the evaluation of the current science curricula have not been fully carried out so far, not only at the national level, but also at the international level (Keser and Akdeniz, 2004). In this respect, it is seen that the recent studies have been periodically conducted by Ministry of National Education, Department of Education Research and Development-*DERD* to assess students' science achievements at national level, named Determining Examination of Students' Achievements-*DESA,* in Turkey. These exams are quite important, but they are not sufficient (DERD, 2003). It is believed that the efforts in the coming years will hopefully provide with more evidence about the implementations of science curricula. These evidences and experiences could perhaps be used to redesign or develop a new curriculum based on the public needs and sources (Keser et al. 2003).

Research in this paper about the science educational standards point out that the studies for developing vocational education standards are carried out to improve vocational education with a project named 'reinforcement of vocational education system' (PRVES, 2004). In addition, some studies have been performed to develop general educational standards concerning physical sources (equipment, hardware, establishment, and building) and human resources (director, teacher, adviser, and inspector) in the schools of curriculum laboratory-SCL that is organized to experiment the new teaching and learning approaches and to try out developed materials (MNE, 2004). As far as present situation is concerned, it is seen that these studies are also insufficient to develop general education standards planned. Furthermore, there are not any significant projects towards developing science education standards among examined ministerial resources.

THE ROLE OF NSES IN DESIGNING, IMPLEMENTING AND EVALUATING ACTIVITIES OF SCIENCE EDUCATION

The *Standards* that also provide criteria can be used by people at the local, state, and national levels to judge whether particular actions will serve the vision of a scientifically literate society. NSES also contains science standards and assesses science teaching program studies which aimed at enhancing the quality of science education (Cajas, 2001). In other words, NSES is an assessment system, which consists of standard criteria developed by professionals to develop and improve any materials/activities for science achievement. All developed projects to improve science education in the U.S., before implementing, are assessed in terms of consistency with national standards. Therefore, programs should go through a very careful investigation process from the planning stage to implementation in order to meet the specified criteria. Only those projects that are in accordance with the national standards can be implemented and assessed through national and international assessment systems such as National Assessment of Educational Progress-*NAEP* and *TIMSS*. By using the indicators of these studies, the effectiveness of the present projects is assessed firstly by project developers. And then, all implemented science programs are assessed comprehensively by a committee. The committee also determines the national success rate of all the implemented science programs based on the results of assessments, scientific studies, institution and district feedback, and socioeconomic trends. Comprehensive reports are prepared and several stakeholder groups are targeted by commissions (BITL, 2000). For each group, several

questions are posed to direct attention to critical issues. A checklist of important steps is then provided to define a comprehensive plan for raising K-12 science student achievement in states, districts, and schools. And then, several wide-ranging intertwined goals in the report are determined at local, state, and federal levels. As an aid to implementation, all of the goals are accompanied by a coordinated set of well-funded project ($5 billion), and action strategies that identify key stakeholders who should take the lead in implementing each strategy are put into practice. Finally, miscellaneous recommendations are made to parents, teachers, administrators, school board members, higher education institutions, state political leaders, business leaders, and the other related institutes (BTIL, 2000).

It is seen that the reasons for preparing science education standards and these reports are very important in terms of the planning, implementing, and evaluating approaches employed, and that recommendations for developing countries as much as the U.S. The aim of this paper is to investigate and present basic features of the NSES project in terms of objectives, practices and evaluation criteria and to develop some suggestions to acquire different views for potential educational research that would be undertaken in developing countries such as Turkey.

WHY THE PROJECT FOR DEVELOPING SCIENCE EDUCATION STANDARDS NEEDED IN U.S.

In these days, people who possess exceptional skills in self-learning, overcoming problems, and making critical decisions require many skills, especially in science related fields. To possess all these skills could be realized through understanding the nature of science in the process of science education (Bayraktar, Karamustafaoğlu, Keser et al., 2002). Other developed countries invest on scientifically and technically literate work forces. To keep pace in global markets, to offer a visible supply for demands of US' changing economy and workplace, to meet the US' democracy needs for an educated citizenry, to make sufficient precautions needed for national security interests, and to understand the deeper value of scientific knowledge, the United States needs having an equally capable of population in science (BTIL, 2000; Bayraktar, Karamustafaoğlu, Keser et al., 2002)).

The program brought hundreds of people together for the science education, which will constitute future's vision. Among them, there were teachers, school administrators, parents, curriculum developers, scientists, faculty members, engineers, and government officials. These people are engaged in many studies and research on teaching and learning (Bayraktar, Karamustafaoğlu, Keser et al. 2002). In meeting comprehensively the needs of students, educators, and society, standards were assessed locally and nationally. In 1989, the project is started with the support of the government. The first standards were put forward for mathematicians and mathematics educators in 1989 (NSES, 2004).

STRUCTURE OF THE NSES PROJECT

National Science Academy was established in the U.S. in order to improve scientific literacy for all students. To achieve its goals, the academy planned NSES project in the second half of the 1980's. The most general objectives of NSES project for science schools are to acquire students: the experience of understanding the natural world and having knowledge and enthusiast about it, the ability to use appropriate scientific principles and functions in decision-making process, the ability to make sound discussions and research on the importance of scientific and technological materials and, increase of scientific literacy, knowledge, and economical productivity in their careers (Bayraktar, Karamustafaoğlu, Keser et al. 2002).

In this respect, the standards, which constituted the NSES program, are organized in seven categories as follows (NSES, 2004):

a) Standards for science teaching.
b) Standards for professional development for teachers of science.
c) Standards for assessment in science education.
d) Standards for science content.
e) Standards for science education programs.
f) Standards for science education systems.

These categories will be presented respectively considering basic features in the following sections.

a) Standards for Science Teaching

The science teaching standards describe what teachers of science at all grade levels should know and be able to do. Teaching standards are divided into six areas: (1) The planning of inquiry-based science programs. (2) The actions taken to guide and facilitate student learning. (3) The assessments made of teaching and student learning.

(4) The development of environments that enable student to learn science. (5) The creation of communities of science learners. (6) The planning and development of the school science program.

Science teaching standards are presented first since effective teaching is the most crucial element of science education. Effective science teachers possess theoretical and practical knowledge in science learning and teaching. They promote active learning with their students by creating appropriate environments. If teachers to achieve the objectives embodied in standards, they should be provided with necessary resources, such as time and materials. Another critical issue emphasized by science teaching standards is equality. All students are capable of full participation and of making meaningful contributions in science classes.

b) Standards for Professional Development for Teachers of Science
The professional development standards present a vision for the development of professional knowledge and skill among teachers. They focus on four areas: (1) The learning of science content through inquiry. (2) The integration of knowledge about science with knowledge about learning, pedagogy, and students. (3) The development of the understanding and ability for lifelong learning. (4) The coherence and integration of professional development programs.

This standard stresses the need for teachers to engage in professional development experiences through their careers. Teachers must be in contact with master educators and reflect on their teaching practice continually. They should also guide all students with diverse experiences, interest, and abilities in making sense of scientific ideas. A major change in development practices is essential as well as change in teaching practices for reforming science education. Teachers should be provided with opportunities to develop theoretical and practical understanding and ability.

c) Standards for Assessment in Science Education
The assessment standards provide criteria against which to judge the quality of assessment practices. They cover five areas: (1) The consistency of assessments with the decisions they are designed to inform. (2) The assessment of both achievement and opportunity to learn science. (3) The match between the technical quality of the data collected and the consequences of the actions taken on the basis of those data. (4) The fairness of assessment practices. (5) The soundness of inferences made from assessments about student achievement and opportunity to learn.

Assessments provide students, teachers, school districts, and policy makers with feedback on effectiveness of implemented programs. This feedback in turn stimulates changes in policy, guides the professional development of teachers, and encourages students to improve their understanding of science. There have also been changes in ideas about assessments in recent years. According to new approach, assessment and learning are two sides of the same coin. Besides, new assessments have focused on higher-order skills rather than simply checking the memorization of facts.

d) Standards for Science Content
The science content standards outline what students should know, understand, and be able to do in the natural sciences over the course of K-12 education. They divided into eight categories: (1) Unifying concepts and processes in science (2) Science as inquiry (3) Physical science (4) Life science (5) Earth and space science (6) Science and technology (7) Science in personal and social perspective (8) History and nature of science

Each content standard expresses what content to be understood and which abilities need to be gained through activities provided for all students in those grade levels. Each standard is followed by a discussion of how students can learn that material. Similarly, the discussion of each standard concludes with a guide to the fundamental ideas that underlie that standard, but these ideas are designed to be illustrative of the standard, not part of the standard itself. Because each content standard includes the knowledge and skills of other standards, those standards designed to be used as a whole.

e) Standards for Science Education Programs
The science education program standards describe the conditions necessary for quality school science programs. They focus on six areas: (1) The consistency of the science program with the other standards and across grade levels. (2) The inclusion of all content standards in a variety of curricula that are developmentally appropriate, interesting, relevant to the student's lives, organized around inquiry, and connected with other school subjects. (3) The coordination of the science program with mathematics education. (4) The provision of appropriate and sufficient resources to all students. (5) The provision of equitable opportunities for all students to the standards. (6) The development of communities that encourage, support, and sustain teachers.

Program standards deal with issues at the school and district level that relate to opportunities for students to learn and opportunities for teachers to teach science. The first three standards address individuals and groups responsible for the design, development, selection, and adaptation of science programs including teachers, curriculum directors, administrators, publishers, and school committees. The last three standards describe the necessary conditions if science programs are to provide proper opportunities for all students to learn science.

f) Standards for Science Education Systems

The science education system standards consist of criteria for judging the performance of the overall science education system. They consider seven areas: (1) The congruency of policies that influence science education with the teaching, professional development, assessment, content, and program standards. (2) The coordination of science education policies within and across agencies, institutions, and organizations. (3) The continuity of science education policies over time. (4) The provision of resources to support science education policies. (5) The equity embodied in science education policies. (6) The possible unanticipated effects of policies on science education. (7) The responsibility of individuals to achieve the new vision of science education portrayed in the standards.

Although the school is the central institution for public education, all parts of the extended system such as school districts, state school system, and the national education system have responsibility for improving science literacy. For example, functions generally decided at the state level include the content of the school science curriculum, the characteristics of the science program, the nature of science teaching, and assessment practices. These policies need to be consistent with the vision of science education described in the standards realizing the vision wholly.

TOGETHERNESS OF SCIENCE EDUCATION AND EDUCATIONAL TECHNOLOGY IN THE EDUCATIONAL STANDARDS CONTEXT

Science and technology are inseparable counterparts of individuals' life. So, the studies to improve educational technology and to enable the students to develop technological literacy are as important as the studies for science education (Roth, 2001). As stated in the eighth five-year plan adequate developments have not been obtained the pervasive use of new technologies in educational area yet (EFYDP, 2000). Therefore, one of the most fundamental objectives of Turkish educational system according to grade level is to benefit from the technological opportunities such as computer technologies, distance learning, new teaching approaches utilizing advanced technology, computer based guidance in the near future.

In U.S., as a developed country, implemented studies about developing standards to improve educational technology have just started, by the years of late 1990s, but has not been completed yet (NETS, 2004). This project has been carried out by International Society for Technology in Education-*ISTE* that is a nonprofit professional organization with a worldwide membership of leaders and potential leaders in educational technology. The main objectives of this project are to obtain a powerful tool with enormous potential for paving high-speed highways from outdated educational systems to systems capable of providing learning opportunities for all, to serve better the needs of 21st century work, communications, learning, and life. Another primary goal of the NETS project is to enable stakeholders in Pre K-12 education to develop national standards for educational use of technology that facilitate school improvement in the United States. The NETS Project is developing standards to guide educational leaders in recognizing and addressing the essential conditions for effective use of technology to support Pre K-12 education. Completed parts of these standards are Technology Foundation *Standards for Students*, describing what students should know about technology and be able to do with technology, and *Connecting Curriculum and Technology*, providing curriculum examples of effective use of technology in teaching and learning. The other parts of these standards are *Educational Technology Support Standards*, describing standards for professional development, systems, access, and support services which are essential support to effective use of technology, and *Standards for Student Assessment and Evaluation of Technology Use*, describing various means of assessing student progress and evaluating the use of technology in learning and teaching, which will be developed and refined more on forthcoming days (NETS, 2004). Moreover, *Standards for Technological Literacy-STL* was developed by International Technology Education Association-*ITEA* (STL, 2004; Cajas, 2001). The content standards in *STL a*rticulate what needs to be taught in K–12 laboratory-classrooms to enable all students to develop technological literacy. Technological literacy is the ability to use, manage, understand, and assess technology (Cajas and Gallagher, 2001). The standards were built around a cognitive base as well as doing/activity base, and they include assessment checkpoints at specific grade levels (K–2, 3–5, 6–8, and 9–12).

Regarding the effects of using technology in educational practices in today's world, it is clearly seen that developments in the field of educational technology have a very significant place during the obtaining process of expected improvements in teaching and learning science.

RECOMMENDATIONS

Considering the expectations of contemporary world from individuals and rising problems in current science education process, adopted approaches to solve their problems by developed countries are very important especially for a developing country such as Turkey. These approaches comprise (1) developing science education standards, and (2) developing materials according to these standards or criteria, (3) assessing students' science achievements at national and international level and evaluating the science curricula in implementing process, and (4) carrying out reports about students' science achievements and factors affecting this process by comprehensive committee with the stakeholders.

Although the general objectives of science curriculum development studies performed in the U.S. have similar characteristics, they differ in terms of requirements of meeting the science standards from those in Turkey. However, in Turkey, general and specific objectives of science curricula have been accepted as standards from some official surroundings. Actually, the prepared curricula according to these standards proved that they possessed highly applicable and serviceable properties, since they were assessed locally, and nationally, and met the needs of students, educators, and society's comprehensively.

National standards are also an assessment system consisting standard criteria developed by professionals to develop and to improve any materials/activities for science achievement. Inasmuch as all developed projects to improve science education in the U.S. are assessed in terms of consistency with national standards before implementing, developed projects and programs should go through a very careful study process from the planning stage to implementation in order to meet the specified criteria. As a result, only projects that are in accordance with the national standards can be implemented and assessed through national and international assessment systems. Therefore, it could not be pretended not to see the importance and the role of standards in developing the process of science teaching/learning materials for policy makers, and project/curriculum developers.

Determining national and international assessments about students' science achievements are also extremely significant in the process of improving science teaching/learning because they have been seen as a springboard for all improvement activities. For instance, Turkey only participated in International TIMSS-R 1999, repeating TIMSS 1995, at certain educational levels and ranked 33rd among 38 countries (TIMSS, 1999, DERD, 2003). Hence, Turkey should participate constantly in this type of international assessments to determine the changes of students' science achievements. At least, next one will be held in 2006 (TIMSS, 2004). So, it is suggested that Turkey should make necessary arrangements to participate in 2006 international assessments at related educational level. On the other hand, the evaluation of the current science curricula have not been fully carried out so far, both at the national and international levels. So, it is seen that the recent studies have been periodically conducted to assess students' science achievements at national level, named in Turkish ÖBBS, by Ministry of National Education, Department of Education Research and Development-*DERD* are quite important (DERD, 2003). Indicators of these studies comprise of not only information about students' science achievements but it also about the effectiveness of the present science curricula. There will be some major contributions to educators and researchers to make inferences about the factors such as teachers, student, and parental characteristics, structure of materials, ITT, the use of learning/teaching techniques, structural properties of learning environments, and the entrance exams for schools the entrance exams for schools respectively secondary, high schools, universities, etc. which are influencing the quality of science education in Turkey.

It has to be considered that the developed recommendations in this study to improve the quality of science education and to solve our present problems towards science teaching/learning process in Turkey are so important for decision/policy makers, researchers, higher education institutions, and the other related institutes. As a consequence, they can be stated briefly as follows;

- to determine meeting level of objectives stated in eighth five-years development plan,
- to assign meeting degree of goals indicated in science curricula,
- to improve the science teacher education according to contemporary approaches in pre-service and in-service,
- to use the newest instructional and assessment methods effectively,
- to develop technology-supported supplementary materials for teachers and students during their science teaching/learning activities,

- to benefit from the opportunities such as computer technologies, distance learning, new teaching approaches utilizing advanced technology, computer based guidance, provided by technology at maximum level,
- to redesign the science learning environments to perform more effective science education activities in the schools,
- to obtain more extensive information about the degree of our students' national and international science achievements,
- and to determine the degree of effectiveness of the current science curricula, research have to be planned extensively, and then the reports have to be performed by committee who will be organised by the participants affected from this process directly. According to Bayraktar, Karamustafaoğlu, Keser et al. (2002) about the indicators of the comprehensive reports, some arrangements stated as follows have to be executed to improve science education in Turkey.

- Study groups of teachers, school administrators, parents, and the other stakeholders should be organised.
- These study groups should collaborate to develop the science education standards to improve science achievement in light of the findings.
- The science education standards should be constructed from subcategories such as instruction, professional development, assessment, content, educational system, and curriculum structure.
- The science curriculum implemented in the schools should be developed by those who are experts in this field to check having the consistency of the science curriculum with the determined standards and reorganize with pilot studies.
- The best techniques and methods to teach subjects to students well should be determined and transferred to teachers and student teachers during ITT and in-service courses by supporting good technological infrastructure.

In summary, suggestions posed regarding the future of science education, which will possibly make important dimensions of progresses are vital for Turkey as a developing country as much as developed countries. In this respect, it is thought that carrying out national assessments periodically and participating in international assessment studies are essential. The general objectives of present science education curricula as well as proposed science standards should be reorganized in line with the findings of these assessments. Restructuring the developed science standards based on the data obtained through participation of international assessments should be among the long-term goals.

REFERENCES

Ayas, A., Çepni, S., and Akdeniz, A. R. (1993) Development of the Turkish secondary science curriculum, *Science Education 77*(4) 433-440.

Bayraktar, Ş., Karamustafaoğlu, O., Keser, Ö. F., Yeşilyurt M., Köse, S., (2002) *The development of scientific educational standarts in science education: Recommendations for developing countries*, Paper presented at meeting of the Changing Times and Changing Needs, First International Education Conference, Eastern Mediterranean University, Famagusta, North Cyprus.

BSL (2004)Benchmarks for science literacy, Retrieved Feb. 10, 2004, from http://www.project2061.org/tools/benchol/bchin.htm

BITL (2000) *Before It's Too Late,* A report to the nation from the National Commission on Mathematics and Science Teaching for the 21st Century, U.S. Department of Education, Education Publications Center, Washington, DC.

Cajas, F. (2001) The science/technology interaction: Implications for science literacy, *Journal of Research in Science Teaching, 38* (7), 715-729.

Cajas, F. and Gallagher, J. J. (2001) The independence of scientific and technological literacy, *Journal of Research in Science Teaching, 38* (7), 713-714.

CPU (2004) Constructing Physics Understanding Project, Retrieved Feb. 12, 2004, from http://cpuproject.sdsu.edu/CPU/main.html

DERD (2003) *TIMSS 1999 Turkey Report*, Ministry of National Education, Department of Education Research and Development, Ankara.

DESA (2002) Determining Examination of Students' Achievements, Republic of Turkey, Ministry of National Education, Department of Education Research and Development, Retrieved April 15, 2004, from http://earged.meb.gov.tr/odbs/icindekiler.htm

EFYDP (2000) Eighth Five-Year Development Plan (2001-2005), Republic of Turkey, Prime Ministry, State Planing Organization of Turkey, Retrieved Feb 5, 2004, from http://plan8.dpt.gov.tr/

Jonassen, D. (2003) Using cognitive tools to represent problems*, Journal of Research on Technology in Education*, *Spring, 35*(3), 362-381.

Keser, Ö. F., Akdeniz, A. R. (2002, September 16-18*) Examining factors affecting the traditional learning environments*, Paper presented at the 5th Science Education Congress, Faculty of Education, Middle East

Technical University, Ankara, Proceeding retrieved Feb. 15, 2003, from http://www.fedu.metu.edu.tr/ufbmek-5/b_kitabi/PDF/Fizik/Bildiri/t123DD.pdf

Keser, Ö. F. (2003) Designing and implementing a constructivist learning environments for physics education, Unpublished PhD Thesis, Karadeniz Technical University, Trabzon.

Keser, Ö. F., Özmen, H., Akdeniz, F. (2003) Energy, environment and education relationship in developing countries' policies: A case study for Turkey, *Energy Sources*, *25* (2) 123-133, Feb.

Keser, Ö. F., Akdeniz, A.R. (2004, April 17) *New trends in education and improving physics education in Turkey*, Paper presented at the Symposium of New Trends in Education, Symposium Proceedings [CD], İzmir Özel Tevfik Fikret Okulları, İzmir.

Kesideu, S. (2001) Aligning curriculum materials with national science standards: The role of project 2061's curriculum-materials analysis procedure in professional development, *Journal of Science Teacher Education, 12*, 47-65.

MNE (2004) Republic of Turkey, Ministry of National Education, Retrieved, Feb. 20, 2004, from http://www.meb.gov.tr

NETS (2004) National Educational Technology Standards, Retrieved, March 17, 2004, from http://cnets.iste.org/

NSES (2004) National Science Education Standards, Retrieved, Jan. 20, 2004, from http://www.nap.edu/readingroom/books/nses/html/

NRCR (1998) National Research Center Report, TIMSS High School Results Released, No:8, p. 1-2, TIMSS U.S.

PRVES (2004) Project of Reinforcement of Vocational Education System, Retrieved, June 5, 2004, from http://www.megep.meb.gov.tr/etkinlik/egitim.html

P2061 (2004) Project 2061, Retrieved, Feb. 10, 2004, from http://www.project2061.org/about/default.htm

Roth, W. M. (2001) Learning science through technological design, *Journal of Research in Science Teaching, 38* (7), 768-790.

SFAA (2004) Science for All Americans, Retrieved Feb. 5, 2004, from http://www.project2061.org/tools/sfaaol/sfaatoc.htm

STL (2004) Standards for Technology Literacy, Retrieved, March 10, 2004, from http://www.iteawww.org/TAA/Publications/STL/STLMainPage.htm

STS (2004) Science, Technology, and Society Program, Retrieved March 10, 2004, from http://trochim.human.cornell.edu/gallery/chakane/stsprog.htm

TIMSS (1999) Third/Trends International Mathematics and Science Study, Retrieved Feb. 20, 2003, from http://isc.bc.edu/timss1999.html

TIMSS, (2004) Schedule of Third/Trends International Mathematics and Science Study, Retrieved Feb. 20, 2004 http://isc.bc.edu/timss2003i/schdule.html