Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.7, No.20, 2016

Science Process Skills in Science Curricula Applied in Turkey

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This research is presented as the summary proceeding at the Innovation in Science Education Conference that took place between March 23 and 25, 2016 in Czech Republic.

Abstract
One of the most important objectives of the science curricula is to bring in science process skills. The science process skills are skills that lie under scientific thinking and decision-making. Thus it is important for a science curricula to be rationalized in such a way that it brings in science process skills. New science curricula were introduced in Turkey in 2013. The purpose of this study is to analyze these science curricula that came into effect from science process skills perspective. The research is conducted by situational study method through document analysis. It is thought that the research findings will provide data for comparison-based studies.
Keywords: Science process skills, Science curricula, Science education

1. Introduction

One of the important objectives of education in our day is to bring in the pupils the scientific thinking skills and the science process skills. In the recent years, many countries put emphasis on the scientific thinking and the science process skills in their curricula. Cepni et al. (1997) defined the science process skills as the core skills that guide in research means and methods, that enable the easy learning and persistency of sciences, and that provide the pupils to be responsible and active in their own learning. Arslan and Tertemiz (2004: 4), articulated the science process skills as 'the developer of self-responsibility in pupils' learning that enable easy learning in classes and that supplies the pupils to be active and structurize their knowledge.' Based on these definitions, it may be suggested that the science process skills involve means and methods to reach scientific information and thus allow the pupils to think scientifically.

The science process skills involve skills that require more complex experiences such as the ability to observe that we develop and utilize naturally even in our very early ages, in addition to comparison skills, data gathering, data interpretation and ability to hypothesize. Tan and Temiz (2003) approached the science process skills as observation, classification, quantification, correlating number and space, forecasting, data recording, data using and modeling, data interpretation and making inferences, determining variables, changing and controlling variables, hypothesizing and testing and experimentation skills. Arslan and Tertemiz (2004: 5) investigated science process skills also from the affective perspective. In cognitive aspect, there are the skills that enable to observe, forecast, explain, hypothesize, ask questions, conduct researches, plan and produce, and communicate. In affective aspect, there are the skills that enable to adapt to reality, respect proof, be curious, be flexible, think critically, take risk and question.

Science process skills are comprised of many skills groups from basic to complex. In many resources (Padilla, 1990; Martin, 1997; Kilic, 2006), this skills group is classified as core and consolidated science process skills. The core science process skills involve observation, comparison, classification, inferring, forecasting, communication and quantification skills. The consolidated science process skills, however, involve determining and control of variables, hypothesizing and testing, data gathering and interpretation, operational definition, experimentation and modeling skills.

The basic science process skills are considered as the prerequisite of integrated science process skills. In this respect, the integrated science process skills may involve utilizing many basic level skill areas (Sen and Nakiboglu, 2012). This multidimensionality requires presenting the science process skills to pupils that are appropriate to their levels and guide them to utilize these skills in every sphere of life (Ango, 2002).

One of the major changes in the recent Turkish education system changes is the acceptance of the new education system. By this system, education system is divided into three steps, primary, middle and high school. Each step lasts 4 years. In this context, changes were also made in the science curricula (MoNE, 2013). Lastly, based on the results of these adjustments in the mandatory education, the vision of the science curricula that was rearranged and came into effect in 2012 was defined as to "bring up all the pupils as science-literate individuals" (MoNE, 2013:1). The science-literacy in the vision statement is a multidimensional concept that involves the science process skills. For this reason, it is stated that in order for the pupils to be science-literate in science curricula they need to be individuals who are able to utilize their science process skills (MoNE, 2013). Learning areas in the science curricula are grouped under the names of knowledge, skill, perception and science-technology-society-environment (STSE). The science process skills are listed under the learning area of skill.

In order to keep pace with the scientific and technological developments in the world and to adapt to environment, the science process skills of individuals should be developed. By this means, it may be possible to

find solutions to problems that will be faced during change and produce genuine products (Celep and Bacanak, 2013). One of the important factors of educating individuals according to the necessities of the time is the education programs. It is important to determine to what extent the qualifications that we desire the pupils to possess are represented in the curricula. For this reason, this research aims to determine to what extent the science process skills are represented in the curricula. For this purpose, answers to the following questions were sought.

1. Where do the science process skills stand in the general objectives of the curricula?
2. How do the science process skills fall within the acquisitions of the curricula?
3. How do science process skills take form based on grade levels?

2. Method

The research is a case study based on document analysis, one of the qualitative research methods. In the research, science curricula taught in primary school grades 3, 4 and secondary school grades 5, 6, 7 and 8 are examined as the document. Case study, which is one of the qualitative research methods, is the research approach in which one or more cases are examined closely (Yildirim and Simsek, 2011) and is useful in sharing experiences in the field-specific studies (Stake, 2005). In this study, the general objectives of 2013 science curricula are depicted, the acquisitions were examined from the science process skills perspective in each grade level, and were compared in their representation in different grade levels.

3. Findings

The findings on research problems are as follows.

3. 1. Where do the science process skills stand in the General Objectives of the Curricula?

General objectives of the curricula are articulated in 12 articles.

1. Bringing in core knowledge in Biology, Physics, Chemistry, Earth, Sky and Environmental Sciences, Health and Natural Disaster,
2. Adopting the science process skills and scientific research approach and finding solutions to the problems faced in the process of exploring the nature and understanding human-environment relations,
3. Creating awareness on how science affects society and technology and how society and technology affect science,
4. Realizing the mutual interaction among individual, environment and society and raising the consciousness on sustainable development of society, economy, natural resources,
5. Raising the consciousness on career in sciences,
6. Ensuring that responsibility about daily life problems is taken and that sciences knowledge, science process skills and other life skills are utilized in solving these problems,
7. Helping understand how scientists form scientific knowledge, what processes this knowledge undergoes and how it is used in new researches,
8. Contributing in helping understand that science is produced as a joint effort of scientists from all cultures and creating sense of appreciation for the studies,
9. Ensuring appreciation of science's contribution in the development of technology, the solving of societal problems and the comprehension of relationships in natural environment,
10. Arousing curiosity and interest, developing attitude towards the facts of nature,
11. Helping in realizing the importance of security in scientific studies and contributing in its practice,
12. Developing scientific thinking habits by using socio-scientific matters.

When general objectives are examined, it may be suggested that almost all objectives involve bringing in science process skills. As can be observed in the following table, while objectives 2, 6, 7, 11 and 12 directly articulate the use of science process skills and thus bringing in these skills, other objectives involve bringing in qualities such as scientific thinking, curiosity towards natural events, revealing the relation of science with other areas, possession of the scientific knowledge, appreciation and thus implicitly serving in developing the science process skills.

Table 1. Objectives with regard to Science Process Skills in Science Curricula

Objectives involving the improvement of science process skills	Objectives that can help improve the science process skills
2. Adopting the science process skills and scientific research approach and finding solutions to the problems faced in the process of exploring the nature and understanding human-environment relations, 6. Ensuring that responsibility about daily life problems is taken and that sciences knowledge, science process skills and other life skills are utilized in solving these problems, 7. Helping understand how scientists form scientific knowledge, what processes this knowledge undergoes and how it is used in new researches, 11. Helping in realizing the importance of security in scientific studies and contributing in its practice, 12. Developing scientific thinking habits by using socio-scientific matters.	3. Creating awareness on how science affects society and technology and how society and technology affect science, 8. Contributing in helping understand that science is produced as a joint effort of scientists from all cultures and creating sense of appreciation for the studies, 9. Ensuring appreciation of science's contribution in the development of technology, the solving of societal problems and the comprehension of relationships in natural environment, 10. Arousing curiosity and interest, developing attitude towards the facts of nature,

3. 2. How do the science process skills fall within the acquisitions of the curricula?

Acquisitions of science process skills are not included in science curricula. However, it is stated that, in order for realizing the vision of enhancing all pupils to be science-literate, the Science Curricula has been designed based on correlating subject areas of Living Creatures and Life, Substance and Change, Physical Phenomenon and Earth and Universe with the science process skills, life skills, affective domain(AD) and Science-technology-society-environment(STSE) learning areas, and correlating acquisitions and scientific knowledge with skill, affective domain and daily life. Samples of acquisition for each grade level that take place in the science curricula and science process skills are listed as follows:

Table 2. The Science Process Skills within the Acquisitions of the Curricula

Grade	Acquisition Samples
3	➢ Examines the moving creatures and expresses their movement features (Observation) ➢ Classifies substances as living or lifeless by using the surrounding samples (Comparison-classification) ➢ Makes inferences about the convergence and divergence of sound source and its location by using the sense of hearing (Making inferences)
4	➢ Relates exercise, breathing and pulse. (Interpretation and making inferences) ➢ Quantifies and compares different substances' masses and volumes. (Comparison-classification) ➢ Creates solutions to reduce light pollution. (Forecasting)
5	➢ Makes inferences about the movement of food in the body through blood after digestion. (Making inferences) ➢ Quantifies the size of force with dynamometer and states the unit of force. (Quantification) ➢ Determines the distinguishing features of pure substances such as melting, freezing and boiling points through experiments. (Designing experiment-conducting experiment-quantification)
6	➢ Explains the differences in physical and chemical changes by observing several events. ➢ Calculates the densities of various substances according to the experiments s/he designed. ➢ Forecasts the variables of the brightness of light bulb in an electrical circuit and tests by experimenting these forecasts.
7	➢ Presents the relationship between senses of smell and taste through an experiment s/he designed. ➢ Names the gravity force that affects the mass in weight, defines the weight as a force and quantifies its size with a dynamometer. ➢ Makes inferences that white light is the combination of all colors of light.
8	➢ Explains chemical bond concept and classifies the bonds based on their ionic and covalent features. ➢ Observes the effects of acid and base on various substances. ➢ Conducts experiments on the types of electrification and observes the results.

In the above table, samples of acquisition for each grade level up to 8th grade that involve science

process skills are listed. The acquisition statements depict which knowledge pupils will reach by utilizing which science skills. There are also the acquisitions in the curricula that only involve obtaining information or that are correlated with STSE or AD. For example: "Comprehends the general features of acids and bases and gives examples from daily life"(MoNE, 2013:41). This acquisition that is in the 8th grade's "Substance and Change" learning area is an acquisition of knowledge domain. Additionally, this acquisition that is expressed with the statement "Questions the chemistry industry's development in Turkey from past to present" is an acquisition of STSE learning area.

In the science curricula there are many acquisitions of science process skills. The following diagram demonstrates the ratio of acquisitions that do or do not involve science process skills.

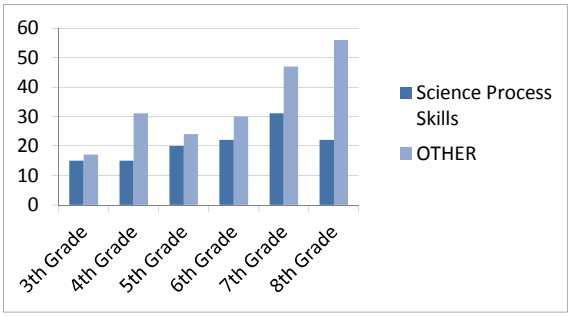

Figure 1. The ratio of acquisitions that do or do not involve science process skills.

The diagram depicts the ratio of acquisitions that involve science process skills to the sum of other learning areas (Knowledge-STSE and AD). When ratios are examined, it is observed that science process skills in the acquisitions are intensely present.

3. 3. How do science process skills take form based on grade levels?

When examining the content of the science curricula that is applied in Turkey, it is observed that same learning areas exist in each grade level. Even though the content is not completely spiral, it is observed that the repeating subjects in higher grades are more complex and detailed. In these circumstances, the question of "do science process skills get evenly more complex and deepen, when pupils move to higher grade levels" comes to mind. The following diagram depicts the distribution of science process skills based on grade levels.

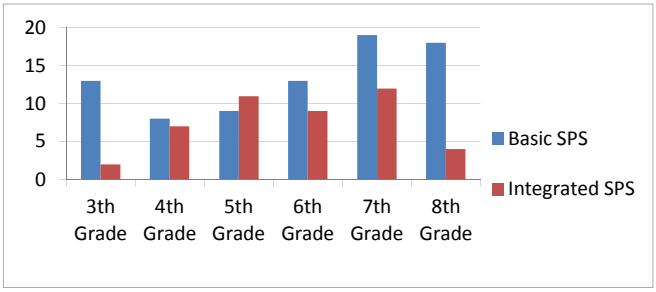

Figure 2. The distribution of science process skills based on grade levels.

It is observed from the diagram that more emphasis in curricula is put on basic science process skills compared to integrated science process skills. Besides it cannot be stated that integrated science process skills are utilized more as the grade level increases. Thus as seen in the diagram, an increase in integrated science process skills is not observed towards the 8th grade.

4. Conclusion and Discussion

Based on the findings of the research, science process skills is represented to a large extent in the general objectives of science curricula that is applied in Turkey. Science attitude and skills are observed in many of the statements in general objectives. It is determined that science process skills in the acquisitions are intensely present. It is observed that the science process skills in the acquisitions that we may also define as the specific objectives of the subject are expressed more compared to the other skills. Kilic et al. (2008: 54) expressed that one of the most significant objectives of science education in countries like America (AAAS, 2005), England,

Canada (OME, 2005) is to improve science-literacy and that this trend in science education is widespread in many countries including Turkey. The reflections of this trend are observed in the general objectives and acquisitions.

According to another finding of the research, the basic science process skills are emphasized more in the curricula compared to integrated science process skills. Similar to the previous curricula, it is determined that more emphasis is put on basic science process skills (Kilic et al, 2008). Additionally a gradual complex acquisitions structure in higher-grade levels cannot be stated.

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