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The Examination of Secondary Education Chemistry Curricula Published between 1957-2007 in terms of the Dimensions of Rationale, Goals, and Subject-Matter

Bülent PEKDAĞ[a]
Balıkesir University

Hilal EROL[b]
Balıkesir University

Abstract

Fifteen secondary education chemistry curricula published from 1957 until 2007 were examined based on the dimensions of rationale, goals, and subject matter. An examination of documents in the scope of qualitative research was carried out in the study. The goals included in the examined chemistry curricula were analyzed according to the cognitive, psychomotor, and affective domains. Subject matters were analyzed by example, concept or theory/model and in terms of the statuses of object, event, property, or semiotic representation. As a result, it was determined that chemistry education in Turkey had passed through six different periods in the fifty year process. It was determined that in setting down curriculum goals, a preference had been attached to the cognitive domain rather than to the psychomotor and affective domains. The number of elements of chemistry knowledge differed in the various periods. Some chemistry curricula were based on teaching chemistry with examples while some were based on teaching chemistry with concepts.

Key Words

Chemistry Curriculum, Curriculum Analysis, Bloom's Taxonomy, Classification of Chemistry Knowledge.

At various times over the years, the restructuring of teaching curricula in the system of education in Turkey has become a matter of discussion (Demirel, 1992; Gözütok, 2003; Milli Eğitim Bakanlığı [MEB], 2007b; Özat, 1997; Tekışık, 1992; Turgut, 1990). Most recently, in the 2000's, new teaching curricula based on a constructivist learning approach have begun to be developed in Turkey (Açıkgöz, 2003). The new teaching curricula have been drawn up on the primary and secondary school levels with the aim of producing educated individuals equipped with the human qualities demanded by the contemporary age (Karabulut, 2002; Korkmaz, 2005; Kutlu, 2005).

When the scientific studies on chemistry curricula are examined, it is observed that such studies can be grouped under three main headings. These are: (*i*) studies on the history of chemistry teaching curricula (Ayas, Özmen, Demircioğlu, & Sağlam, 1999; Gözütok, 2003; Turgut, 1990; Ünal, Coştu, & Karataş, 2004; Yılmaz & Morgil, 1992); (*ii*) studies examining the elements of chemistry curricula (goals, subject matter, teaching-learning processes and evaluation) (Ayas, Çepni, & Akdeniz, 1993; Çoban, Uludağ, & Yılmaz, 2006; Dalmaz, 2007; Gök, 2003; Koray, Bahadır, & Geçgin, 2006; Küçük & Gök, 2006; Seçken & Morgil, 1999); and (*iii*) studies evaluating teachers' views on chemistry curricula (Ercan, 2011; Kayatürk, Geban, & Önal, 1995; Özat, 1997; Seyit, 2010).

a **Bülent PEKDAĞ, Ph.D.**. is currently an assistant professor in Chemistry Education. His research interests include technology-supported chemistry teaching, chemistry curricula, and the history of chemistry. *Correspondence*: Assist. Prof. Bülent PEKDAĞ, Balıkesir University, Necatibey Education Faculty, Chemistry Education, Balıkesir/Turkey. E-Mail: pekdag@balikesir.edu.tr Phone: +90 266 241 2762/542 Fax: +90 266 249 5005.

b **Hilal EROL** Balıkesir University, Necatibey Education Faculty, Chemistry Education, Balıkesir/Turkey.

This study sought to examine the chemistry curricula published in the 50-year interval between 1957 and 2007, based on the *rationale* behind their publication, the *goals* set forth, and in terms of *subject matter*.

Theoretical Framework

Elements of the Curriculum

There are differing views on which elements comprise a curriculum. Taba (1962) and Herrick (1965), for example, stated that the elements of a curriculum were aims, goals, subject matter, learning experiences and evaluation (cited in Saylan, 1995). Sönmez (2001) stated that the basic elements of a curriculum were goals, behavior, subject matter, educational status and testing status. According to Demirel (2008), the elements of a curriculum were goals, subject matter, teaching-learning processes and evaluation.

Classifying Curriculum Goals

It was seen that in classifying the goals of curricula, the classification suggested by Bloom et al. (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Krathwohl, Bloom, & Masia, 1973) was rapidly adopted and widely accepted. According to Bloom's Taxonomy, goals were classified in three domains. These domains were the *cognitive domain*, the *psychomotor domain,* and the *affective domain* (Ayas, Çepni, Johnson, & Turgut, 1997; Demirel, 2008; Ertürk, 1998; Küçükahmet, 2001; Tekin, 1996).

Classifying Knowledge in Chemistry

One of the most important goals of chemistry education is to ensure that the knowledge and skills contained in the subject matter of chemistry curricula are transmitted to students. This knowledge consists of chemical concepts and theories. Concepts are associations formed in the mind about a being or object whenever a reference is made to that being or object (Çepni, 2007a). Lawson and Renner (1975) identified two categories of concept in the domain of chemistry–*concrete concepts* and *formal concepts*. The approach of Cantu and Herron (1978) to the classification of concepts was similar.

In chemistry education, some researchers made a classification of three levels of chemical knowledge: *macroscopic*, *microscopic*, and *symbolic* levels (Bowen, 1998; Gabel, 1998, 1999; Gabel & Bunce, 1994; Gabel, Samuel, & Hunn, 1987; Johnstone, 1993, 2000). Le Maréchal and Pekdağ, however, presented a different classification of chemistry knowledge. This classification was based on the two-world model–*perceptible world* and *reconstructed world*. Both worlds include *object*, *event,* and *property* levels. It was stated in this classification that besides the three levels (object, event, property), there was also a need for *theory/model* and *semiotic representation* levels (Le Maréchal, 1999; Pekdağ, 2005; Pekdağ & Le Maréchal, 2006, 2007, 2010). Theory referred to the conceptual system that explained various phenomena or the relationships between phenomena (Yıldırım, 2007). Paradigms, causality, principles and laws were all elements of theory. Models, however, set forth the qualitative and quantitative functional relationships between physical quantities and consist of representations of mathematical forms (Sensevy, Tiberghien, Santini, Laube, & Griggs, 2008; Tiberghien, 1994; Tiberghien & Megalakaki, 1995; Tiberghien, Vince, & Gaidioz, 2009). The semiotic representation level was related to the forms in which knowledge was demonstrated in chemistry. Knowledge in chemistry associated with any level of the perceptible or reconstructed worlds may be presented through different semiotic representations (Duval, 1993, 1995). In short, it is possible to classify any knowledge in chemistry as an *object*, *event*, *property*, *theory/model* or *semiotic representation* register.

Method

Research Model

Since the research was based on an investigation of an existing situation, the descriptive survey model was used in the study (Çepni, 2007b; Gay & Airasian, 2000; Kaptan, 1998; Karasar, 2008).

Sample

The sample for the study consisted of 15 chemistry curricula that were published by the Ministry of National Education (MEB) over the period 1957-2007 (MEB, 1957, 1967, 1971, 1973, 1985, 1991, 1992a, 1992b, 1994, 1996, 1997, 1998, 2002, 2003, 2005a, 2005b, 2007a, 2007b).

Data Analysis

The chemistry curricula examined in the study were analyzed in terms of three different dimensions: *rationale*, *goals,* and *subject matter*. In naming the various sections of the analysis, the terms used for curriculum elements in the literature (Demirel, 2004, 2008; Doğan, 1997; Erden, 1998; Ertürk, 1998; Fidan & Erden, 2001; Hesapçıoğlu, 1994; Sönmez, 2001; Varış, 1996) were taken into consideration. In the dimension of rationale, the decisions taken to change or develop the curricula were analyzed. In the dimension of goals, the statements of goals expressed in the chemistry curricula were analyzed in the light of the classification set forth by Bloom et al. (Bloom et al., 1956; Krathwohl et al., 1973). In the dimension of subject matter, the approach recommended by Le Maréchal and Pekdağ (Le Maréchal, 1999; Pekdağ, 2005; Pekdağ & Le Maréchal, 2006, 2007, 2010) for the classification of chemical knowledge in curricula subject matter was utilized.

Qualitative analysis was employed in the three-way analysis of rationale, goals, and subject matter of chemistry curricula and data were expressed in terms of frequency (f) and percentages (%). To increase the validity and reliability of the analyses carried out in the study, three academics specialized in chemistry education were asked to share their views in the light of their knowledge and experience on the subject of the research.

Results

Rationale Analysis Results

The rationale for publication of the chemistry curricula that emerged over the period 1957-2007 can be collected under three general headings. These three headings are (*i*) the rationale of publishing the curriculum for implementation in all schools; (*ii*) the rationale of publishing the curriculum for implementation in pilot schools, and (*iii*) the rationale of publishing a new curriculum created by collecting all of the curricula in the different types of schools under the same roof and implementing this in all schools. Whenever a new program of chemistry education is designed, the rationale for publishing this program is associated with one of these three dimensions. The rationales for publishing chemistry curricula suggest that over the last 50 years, chemistry education has passed through six different periods. These can be identified as: (*i*) the classic curriculum period; (*ii*) the modern curriculum period; (*iii*) the period in which the difference between classic and modern curricula is eliminated; (*iv*) the period of the course-passing and credit system, (*v*) the period of grade-passing, and (*vi*) the period of constructivist curriculum. Over the course of these six different periods, the status of chemistry courses has gone through changes. While in some periods, chemistry becomes a required course, in other periods, it becomes an elective one.

Goals Analysis Results

It was observed that chemistry curricula had been formulated on the basis of different numbers of goals in the cognitive, psychomotor, and affective domains. The differences lie in how many or how few elements of the particular program were meant to be taught students. In other words, it may be said that the different number of goals that each chemistry program had was related to how much more or less importance was given to the student's relationship with *gaining knowledge* (cognitive domain), *gaining skills* (psychomotor domain), or *developing a particular attitude* (affective domain).

It was observed that in the chemistry curricula examined, it was generally the cognitive domain that was given more importance rather than the psychomotor or affective domains during the formulation of the program. Expressed in another way, at the time the chemistry curricula were being formulated, gaining knowledge was given superiority over gaining skills or attitude. When the goals in 11 chemistry curricula were compared in terms of the three domains, the following order was observed: gaining knowledge (44.2%) > gaining skills (34.6%) > development of attitude (21.2%). This order indicated that the goals of chemistry curricula were formulated by attaching greater importance to the cognitive domain, but importance given to psychomotor and affective domains should also not be underestimated. From another perspective, it was observed that the tradition of preparing educational programs with an emphasis on the cognitive domain was not consistent over the six different periods of development of the educational system in Turkey. The first signs that the tradition had been disrupted were seen in the period of the "course-passing and credit system." Moreover, the idea of setting up curriculum goals to assign the same degree of importance to all three domains (gaining knowledge, skills, and attitude), was more predominantly seen in the period of constructivist curriculum.

Subject Matter Analysis Results

The results of the examination of 15 chemistry curricula in terms of subject matter can be summarized in five points: (*i*) the number of elements of knowledge contained in the curricula differed in the various periods; (*ii*) among the periods in which curricula had the greater number of elements of knowledge, the period of the classic curriculum was more pronounced in this aspect; (*iii*) the example category was more predominant in the classic curriculum period whereas the concept and theory/model categories were pronounced in almost all of the periods; (*iv*) the elements of chemistry knowledge contained in the curricula were in general mostly represented in the concept category, but in some cases, were represented at the highest level in the example category; and (*v*) the elements of chemistry knowledge contained in the curricula in the example category were predominantly of the status of object and those in the concept category were pronounced in almost all of the statuses of chemistry knowledge.

Discussion

The goal of chemistry education today is not to have students memorize scientific information related to chemistry but to give them the scientific attitudes and mental process skills that will enable them to solve the problems in chemistry that they may encounter throughout their lives (Bayrak & Erden, 2007). An effective and meaningful chemistry education must work toward the goal of giving students the opportunity to develop in each of the cognitive, affective and psychomotor domains. Furthermore, providing adequate room in a chemistry curriculum for goals related to all three domains is a necessity if chemistry education is to become effective and meaningful.

The objectives of chemistry education over the past 50 years have been set forth by means of an analysis of subject matter. While some chemistry curricula choose to use *examples* in teaching chemistry (generally using "objects"–nitrogen, bromine, red phosphorus, nitric acid, potassium chlorate, sulphuric acid, etc.), some other programs go the route of teaching chemistry with *concepts* ("with objects"–elements, compounds, metals, halogens, atoms, molecules, etc.; "with events"–chemical reactions, hydrolysis, electrolysis, etc.; "properties"–solubility, temperature, mass, volume, etc.; and "semiotic representations"–formulas, equations, etc.). This situation indicates that over the 50-year period, chemistry curricula have adopted different goals in tackling the teaching of chemistry. In other words, it can be said that the philosophy behind chemistry education has exhibited change over the 50-year period.

Research on chemistry education has been concentrated on three basic pivot points: (*i*) *scientific knowledge* (epistemological studies), (*ii*) *the teacher* (teaching method, technique and strategies) and (*iii*) *the student* (different statuses of learning). Chemistry education is involved with the didactic transposition of scientific knowledge. This transposition takes place in two stages: the transition of scientific knowledge into knowledge that can be taught and the transition from the knowledge to be taught into knowledge that has been learned (Chevallard, 1985; Chevallard & Johsua, 1982). Chemistry educators study how and at what level students are able to assimilate/understand the scientific knowledge constructed by scientists. To review in detail the process of how scientific knowledge is transposed into assimilated or learned knowledge, the following steps have to be taken: (*i*) the curriculum published by MEB must be analyzed; (*ii*) the textbook associated with the curriculum must be analyzed; (*iii*) an analysis must be made of how the teacher transmits the scientific knowledge in the program and in the textbook; and (*iv*) an analysis must also be made of the degree to which students are able to assimilate the knowledge set forth in the curriculum and in the textbook. At the same time, determining what the views of teachers are about the curriculum and the textbook will facilitate understanding this process. The evaluation of the information gathered from analyzing every stage of the process of transposing scientific knowledge into learned knowledge will in its entirety be important for an in-depth understanding and interpretation of the extent to which students have gained knowledge and skills and developed the appropriate attitude. The present study has examined the chemistry curricula published by MEB, concentrating on one of the three pivot points around which chemistry education studies have revolved, namely the pivot point of "scientific knowledge." Investigating the numerous chemistry curriculums published over the relatively long period of 50 years has not made it possible to dwell at this time on the other two pivot points of "teacher" and "student." The knowledge to be attained from these two other pivot points will contribute to constructing a more effective and meaningful of chemistry education.

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