

The Comparison of the Chemistry Education in Science High Schools, Anatolian High Schools and Public High School in Turkey in Terms of "Object and Content"

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Abstract: In this study, the chemistry education in Science High Schools, Anatolian High Schools and Public High Schools in Turkey in terms of "object and content" are compared and it has been descriptively researched if there are any differences among them. To fulfil this aim, literature scan has been done, then internet has been used, lastly chemistry education curriculum in these schools and Tebliğler Periodicals which are published by Turkish Ministry of Education has been investigated. When obtained data has been compared expecting object and content, it is seen that the purposes of Turkish National Education are not put into practice.

Key words: Chemistry education in Turkey, Science high school, Anatolian high school, Public high school, Object and content, Curriculum

Introduction

In the past, economic and political power was based on physical strength, which stood for the population that could fight and produce, whereas today, it is based on the possession of science and technology. While the world population increases rapidly, nourishment and energy resources are consumed with the same speed. As a result of this, too many problems, mainly environmental matters, threaten the mankind. Only the societies that have the brainpower to create science and technology will cope with briefly mentioned problems of this kind (Ayca *et al*, 2002 and Kartal *et al.*, 2001). Since the technology, which is created by getting support from science, assists in the development of the societies, the societies have given importance to science education (YOK/World Bank, 1997; Nivaldo, 2004; Prophet and Vlaardingerbroek, 2003).

Science courses take place in the education programmes of the schools for three purposes (Kaptan, 1999). These are;

To give general instruction about science issues (science literacy),

To cause the students to get idea and hand skills via science courses,

To establish a basis for profession education in science and technology branches.

In Turkey, modern science curriculum in the high schools, which started with Ankara Science High School in 1964, was also put into practice in the Public High Schools in 1980's. Thus, Classic Chemistry Education that the 3rd classes of the secondary schools, the 1st, 2nd and 3rd classes of high schools have and is based on memorization has been replaced by Modern Chemistry Education which is applied only in the high schools and regards thinking as a matter of primary importance (Demirci, 2002).

As the research is going to consider "chemistry education" in Science High Schools, Anatolian High Schools and Public High Schools in Turkey, before all else it is necessary to know the aims of these institutions of education briefly. In respect of this;

a) The aims of Science High Schools are;

To prepare the students who have a high level of intellect and a high capacity of science and mathematics for higher education in science and mathematics,

To provide the bringing up of the superior qualified scientists who are necessary for science and mathematics,

While directing the students towards investigation, to provide the ones who are interested in scientific, technological and new developments with the appropriate studying environment,

To bring up individuals who can use new technology, create new data and prepare new projects,

To provide the students with a foreign language which may help them to do scientific investigations and follow the scientific-technological developments (Official Gazette, 1999 a).

b) The aims of Anatolian High Schools are;

To prepare the students for higher education curriculum in respect of their interests, capacity and accomplishment, To make them learn a foreign language in a level that they can follow the scientific-technological developments in the world (Official Gazette, 1999 b).

c) The aims of Public High Schools are;

Student's growing up as a citizen who has assimilated the national morals of the Turkish Republic, has gained its science understanding, who is hardworking and useful,
Student's reaching the knowledge and culture level whose content is determined by the programmes and which is required to follow higher education,
Student's learning to use his/her knowledge in practice and improving his/her skills in a level that will make choosing a profession easier,
Students gaining good habits and skills, being strong both physically and psychologically (Ministry of Education, 1964).

In the study which takes the principle of "chemistry education in the education curriculum of Science High Schools, Anatolian High Schools and Public High Schools which have different purposes of foundation must be different" as its basis, it is aimed to reveal the differences of the chemistry education in the afore-mentioned institutions of education. The problem towards this aim has been classified as a general question which is "When the chemistry education in Science High Schools, Anatolian High Schools and Public High Schools among the institutions of secondary education are compared in terms of object and content, what is the level of difference?" and two related sub-questions that are "What is the level of 'difference in the chemistry course objects' in Science High Schools, Anatolian High Schools and Public high Schools?" and "What is the level of 'difference in the chemistry course contents' in Science High Schools, Anatolian High Schools and Public High Schools?"

Since the study only contains chemistry as a science branch, the limitations are in this way. For example, literature scan and the evaluation of the object and content of "chemistry education curriculum" in Science High Schools and choosing a science branch in Anatolian High Schools and Public High Schools are done in respect of this. But it is assumed that all the schools, which are included in the study, apply the chemistry education curriculum. It is important to reveal the applications of the chemistry education curriculum in different high schools in respect of validation of Turkish National Education Policy in practice having been tested.

Materials and Methods

As 2002-2003's institutions of secondary education in Kütahya create the investigation environment, Science High Schools, Anatolian High Schools and Public High Schools among the institutions of secondary education in the city centre of Kütahya constitutes example.

Collecting data includes doing literature scan, using Internet, scanning the chemistry education curriculum in Science High Schools, Anatolian High Schools, Public High Schools and Tebliğler Periodicals of the Ministry of Education. Also, interviews have been done with the teachers who work in the city centres of the schools mentioned above. Data has been evaluated with a descriptive study; information, which is gained through the recourses of object, and content that are expected to take place in the education curriculum has been compared; the results have been presented in a systematic order.

Results

The first sub-question of that problem is "What is the level of difference in the chemistry course objects in Science High Schools, Anatolian High Schools and Public High Schools?" When we evaluate this question in respect of "chemistry", "advanced chemistry", and "chemistry applications" courses, we have had the findings below:

Chemistry Course: Chemistry, which is prepared according to exam passing and credit hour system based on the semesters and has been applied in exam passing system since 1991-1992 educational year; which is a common general culture course in all the branches of the High Schools, Anatolian High Schools and High Schools whose education is mostly in foreign language and in the 9th classes of Science High Schools, Anatolian Fine Arts High Schools; which takes place as a branch course in the 10th, and 11th classes of Science and Science High Schools, is given in the 1st, 2nd, 3rd or the 9th, 10th, 11th classes of High Schools. The Ministry of Education as below-mentioned has determined the general objects of the course:

General method which is to be followed in conveying the students to scientific facts that is to bring trying to understand the structure and the nature of the matter at the highest level of the modern science that improves constantly,

To consider the principles which can be used in creating significant and plenty of knowledge important, to avoid giving information that depends on memorization,

To inject to the students that the source of science is the laboratory, to make them to get scientific facts with the experiments done by themselves and to apply to demonstration exhibitions or films in times of impossibility,

To cause the students to gain the habit of discussion and finding on their own in induction with the evaluation of experiment results and practical skills in laboratory studies of chemistry.

To prepare the students for a higher education which is related or based on chemistry course discipline.

The explanations about briefly revealed objects are; in order to develop the students' attitude of gaining knowledge through independent thought, studying and willing efforts, the students must get used to thinking, trying, reading, trying again, getting their own opinions; they must be encouraged to participate in discussions, to search techniques with the new method and to put these into practice; the courses must be away from subjectivity; activities apart from the experiments must go on as the discussions controlled by the teacher; and teaching the students how they will carry on learning all through their lives must be taken basis, which is to teach the ways of learning; students must be made to use their fundamental knowledge in solving the problems which they will come across later; rationalism in Kemalist ideological system, the relationship of rationalism to constructualism and responsibility, the position and importance of science in human life must be mentioned often (Ministry of Education, 1964).

As it is understood, the general aims of the chemistry course in Science High Schools, Anatolian High Schools and Public High Schools are the same. However, in the scope of chemistry education curriculum, only the chemistry courses in the 9th and 10th classes of Science High Schools are two hours more than the 9th classes of Anatolian High Schools, Public High Schools and an hour more than the 10th classes of these.

Advanced Chemistry Course: The Ministry of Education states the general aims of advanced chemistry course, which is 4 hours only in the 11th classes of Science High Schools, in eight articles. When these aims are compared with the general objects of the chemistry course in the 1st, 2nd, 3rd classes of the high schools, it is seen that advanced chemistry course has two different objects apart from the aims of chemistry course. These are; to teach the ways of evaluating the errors in time of experiment with their reasons, and to cause the students to gain the necessary knowledge for using the tools and materials that are appropriate for modern technology in the branches of industry and production (Ministry of Education, 1996).

Applied Chemistry Course: In the 10th and 11th classes of High Schools, Anatolian High Schools and Science Departments of High Schools whose education is mostly in foreign language and in the 10th classes of Science High Schools, the objects of Applied Chemistry Elective Course that is two hours' classes per week, are stated by the Ministry of Education as based on the objects and statements of Chemistry 1,2,3 Course" (Ministry of Education, 1996). In terms of this, applied chemistry course and advanced chemistry course do not have any other objectives except the ones mentioned above. And these objectives are the same with the ones of Science High Schools, Anatolian High Schools and Public High Schools.

The second sub-question of the problem is designated as "What is the level of difference in the chemistry course contents in Science High Schools, Anatolian High Schools and Public High Schools?" According to this, the class level and numbers of class hours of chemistry, advanced chemistry and applied chemistry courses in Science High Schools, Anatolian High Schools and Public High Schools are showed in Table I.

As it is seen on table 1, the 9th classes, in Science High Schools have chemistry courses 4 hours in a week, in Anatolian High Schools and in Public High Schools they have 2 hours in a week, whereas they do not have advanced chemistry and applied chemistry courses except in Science High Schools. The 10th classes in Science High Schools have chemistry course 4 hours in a week, in Anatolian High Schools and in Public High Schools 3 hours in a week. In none of the schools they have applied chemistry course 2 hours in a week. In each high school, the 11th classes have chemistry course 3 hours in a week, they have advanced chemistry course 4 hours in a week only in Science High Schools whereas they do not have applied chemistry course but in Anatolian High Schools they have 2 hours in a week.

The Results of Comparison Article by Article: In Anatolian High Schools and in Public High Schools, class hours of chemistry and applied chemistry courses in the 9th, 10th and 11th classes are equal. Only in Science High Schools, the 10th classes have this course 2 hours in a week

The class hours of chemistry course in the 9th classes of Science High Schools is two hours more than in the 9th classes of other schools. In the 11th class they are equal.

Only the 11th classes of Science High Schools have advanced chemistry courses 4 hours in a week.

After evaluating the difference level of the objects of chemistry course in Science High Schools, Anatolian High Schools and Public High Schools by two questions, now we are going to evaluate the distribution of the contents of chemistry course in terms of subjects and classes.

The distribution of the contents of chemistry courses in terms of subjects and classes showed by a table in the appendix (Table 2). When the table is evaluated as to the 9th, 10th and 11th classes separately;

In the 9th classes: The subjects of chemistry course in the 9th classes of Science High School have 12 sections. These are matter and its properties, classification of matter, compounds with elements which are the subjects of

science 1,2 and scientific study (uncertainty in science, significant numbers, exponential expressions of numbers, pure matters, mixture of gases, gases in air, nomenclature of compounds, formulas and compounds (relative atom and formula scale, the concept of mole and Avagadro number, the calculation of the weight of moles and mole), the gas state of the substance, chemical reactions, dense phases of substance-fluids and solids, the indications of the existence of atom, periodic table, radioactivity (Türkođuz *et al.*, 2000).

The subjects of the chemistry courses in Anatolian High Schools and Public High Schools are the same with the subjects of science 1,2. Only the subjects of chemistry course in Science High School includes all subjects of Chemistry I in addition to the others. Hence, the subjects of chemistry course in Science High Schools are more than in others.

In the 10th classes: The subjects of chemistry course in the 10th classes of Science High Schools, which is called Chemistry II have 6 sections. These are chemical reactions and energy, speed of chemical reactions, balance in chemical reactions, solubility equilibrium, acids and bases, oxidation-reduction reactions.

The chemistry courses in the 10th classes of Anatolian High Schools and Public High Schools includes the gas state of substance, chemical reactions, dense phases of substance (liquids and solids), and radioactivity which are the subjects of Chemistry I. And also includes the subjects of Chemistry II except "oxidation-reduction reactions".

In the 11th classes;

The subjects of chemistry courses in the 11th classes of Science High Schools are chemical bonds, general information about chemistry, alcohols and ethers, hydrocarbons, aldehydes and ketones, carboxylic acids, esters, carbohydrates, aliphatic ammonia derivatives, aromatic compounds which are the subjects of Chemistry III.

The subjects of chemistry courses in the 11th classes of Anatolian High Schools and Public High Schools include oxidation-reduction reactions, which are the subject of Chemistry III and all other subjects of Chemistry III courses in the 11th classes of Science High School.

When Table 2 is investigated, it is obvious that chemistry courses only in the 9th classes of Science High School includes the C, C2 and C6, C7 sections. It is understood that though other subjects, except these, are different in class levels, they are the same with chemistry courses of other high schools.

Applied Chemistry" which is described as "elective branch course" is given in the 10th and 11th classes of Anatolian High Schools and Public High Schools and in the 10th classes of Science High Schools. The Ministry of Education, instead of it, does not state the subjects of the course some principles are declared. For example, Applied Chemistry Course includes the experiments, projects, problems and tests to intensify and improve the subjects of chemistry course.

The fundamental principle is to teach the subjects of these courses as a whole.

The other fundamental points are experiments in the programs of these courses that support and improve the subjects and also other experiments.

The importance of problem solutions and test applications about the subjects of the course is emphasized (Aycan *et al.*, 2000). According to the basic principles, the concept of applied chemistry course is the same in all high schools. Yet, only Science High Schools have Advanced Chemistry I, II course which is in the group of elective courses of 11th classes (Ministry of Education, 1996). In this respect, though Science High School seems different from others, *Chemistry 1,2,3*, the subjects of the 9th, 10th, 11th classes and most of the subjects of *Advanced Chemistry* course are the same. In our research, in terms of subjects, this situation is emphasized by underlying subjects of Chemistry 1,2,3 in high schools, which are similar to *Advanced Chemistry*. The ones that are not underlined are not the subjects of high school 1, 2, 3. So, these do not exist in the content of courses of Anatolian High Schools and Public High Schools.

The subjects of *Advanced Chemistry II* and *I* determined by the Ministry of Education article by article in beloved subtitles (Ministry of Education, 1992 a).

A. *Advanced Chemistry I* Subject:

Chapter I: GASES "Ideal Gas Law", "Kinetic Theory", "Real Gases".

Chapter II: "Vaporisation", "Equilibrium of Liquid Vapour", "Vapour Pressure and Temperature", "Boiling Point", "Heat of Vaporisation", "Melting Point and Melting Heat", "Sublimation and Sublimation Heat", "Phase Diagrams", "Structures of Solids".

Chapter III. SOLUTIONS "Properties of Solutions and Classification", "Units of Concentrations", "Kind of Solutions", "Gas-Liquid Solutions (Henry Law)", "Liquid-Liquid Solutions", "Ideal Solutions (Raoult Law)", "Vapour Pressure of Solutions", "Boiling and Melting Points of Solutions (Colligative Properties)", "Osmotic Pressure", "Distillation".

Chapter IV: IONIC EQUILIBRIUM IN AQUAUS SOLUTIONS "Chemical Equilibrium (Equilibrium Constant, Magnitude of Equilibrium Constants)", "Solubility of Undissolved Salts and Solubility-Product", "Common-Ion Effect", "Fractional Precipitation", "Acids and Bases", "Arhenius, Brønsted-Lowry and Lewis Acids and Bases", "Strength of Acids and Basis", "Concept of pH and pOH", "Self-Ionisation of Water", "Weak Acids", "Polyprotic Acids", "Qualitative Description

of Voltaic Cells", "Hydrolysis Equilibrium", "Buffer Solutions", "Acid-Base Indicators", "Acid-Base Titration", "Strong Acid-Strong Base Titration", "Weak Acid-Strong Base Titration".

Table 1: The distribution of chemistry, advanced chemistry and applied chemistry courses in terms of classes and class hours

Courses High Schools and classes	Science High Schools			Anatolian High Schools			Public High Schools		
	9th	10th	11th	9th	10th	11th	9th	10th	11th
Chemistry	4	4	3	2	3	3	2	3	3
Advanced Chemistry	-	-	4	-	-	-	-	-	-
Applied Chemistry	-	2	-	-	2	2	-	2	2

Table 2: The Distribution of the Contents of Chemistry Courses in Terms of Subjects and Classes

Classes and subjects* High schools and classes	Science High Schools			Anatolia High Schools			Public High Schools		
	9	10	11	9	10	11	9	10	11
a, b, c ₁ , Matter and its Properties	X			X			X		
a, b, c ₂ , Classification of Matter	X			X			X		
a, b, c ₃ , Elements, Compounds	X			X			X		
a, b, c ₄ , Structure of Matter	X			X			X		
C ₅ , Scientific Study									
-Uncertainty in Science									
-Significant Figures	X								
-Exponential Showing of Figures									
-Pure Matters									
-Mixture									
-Gases in Air									
C ₆ , Symbol, Formula and Nomenclature of Compounds	X								
-Relative Atom and Formula Weight									
-Mol Concept, Avagadro Number									
-Calculation of Mole Weight									
-Mole Calculation									
C ₇ , -Gas State of Matter	X				X			X	
C ₈ , -Chemical Reactions	X				X			X	
C ₉ , -Liquids and Solids	X				X			X	
C ₁₀ , -Evidence for Atoms	X								
C ₁₁ , -Periodic Table	X								
C ₁₂ , -Radioactivity	X				X			X	
D ₁ , -Chemical Reactions and Energy	X				X			X	
D ₂ , -Rates of Chemical Reactions	X				X			X	
D ₃ , -Chemical Equilibrium	X				X			X	
D ₄ , -Solubility Equilibrium	X				X			X	
D ₅ , -Acids and Bases	X				X			X	
D ₆ , Oxidation-Reduction Reactions	X				X			X	
E ₁ , -Chemical Bonds	X				X			X	
E ₂ , -Introduction to Organic Chemistry	X				X			X	
E ₃ , -Hydrocarbons	X				X			X	
E ₄ , -Alcohols and Ethers	X				X			X	
E ₅ , -Aldehydes and Ketones	X				X			X	
E ₆ , -Carboxylic Acids	X				X			X	
E ₇ , -Esters	X				X			X	
E ₈ , -Carbohydrates	X				X			X	
E ₉ , -Aliphatic Ammonia Derivatives	X				X			X	
E ₁₀ , - Aromatic Compounds	X				X			X	

*Subjects: Science 1_a, 2_b; Chemistry I_c, Chemistry II_d, Chemistry III_e.

Chapter V. OXIDATION-REDUCTION REACTIONS "Oxidation and Reduction", "Concept of Half-Reaction", "Electrochemical Cells", "Standard Electrode Potentials", "Standard Cell Potentials", "Effect of Concentrations on Cell Voltage (Nernst Equation)", "Cell Voltage and Equilibrium Constant", "Concentration Cells", "Oxidation Steps", "Balancing Chemical Equations", "Electrolysis", "Electrolysis of Melting Salts", "Electrolysis of Aqueous Solutions", "Faraday Laws".

Advanced Chemistry II Subjects: Chapter I. CHEMICAL THERMODYNAMICS "Spontaneous Change", "States Functions", "First Law of Thermodynamics", "Free Energy", "Enthalpy", "Thermo chemistry (Hess Law)", "Dependence of Enthalpy on Temperature", "Second Law of Thermodynamics", "Entropy Changes", "Third Law of Thermodynamics", "Changes of Equilibrium Constant with Temperature", "Thermodynamics and Colligative Properties".

Chapter II. CHEMICAL KINETICS "Reaction Rate", "Reaction Order", "Effects of Changing Rate".

Chapter III. ORGANIC CHEMISTRY "Bonding Capability of Carbon", "Molecule Formulas of Organic Compounds", "Nomenclature of Organic Compounds and Isomerism", "Hydrocarbons", "Alkanes", "Alkenes", "Alkynes", "Aromatic Hydrocarbons", "Important Functional Groups", "Alcohols and Ethers", "Aldehydes and Ketones", "Carboxylic Acids, Esters and Amides", "Fatty Acids, Fats and Soaps", "Amines", "Amino Acids and Proteins", "Optical Isomers".

Conclusions

Though the objects and contents of chemistry teaching programs are the same with the ones in Anatolian High Schools and Public High Schools, the objects of chemistry and advanced chemistry courses in Science High Schools are different from those in Anatolian High Schools and Public High Schools. Also, whereas weekly class hours of chemistry course are equal in Anatolian High Schools and Public High Schools, class hours in Science High Schools are more than in others. This situation is similar in the case of subjects.

It seems natural that the objects and contents of courses change according to the names of the schools. However, when the conditions of Turkey regarded, it is clear that there are some other reasons of it. As it is in all over the word, the aim of a student who goes to the Public High School is to pass the university entrance exam. Deciding the type of high school is equal to deciding the type of the university. Chemistry education in Science High Schools is better than in Anatolian High Schools and Public High Schools. Yet, Science High Schools do not have enough Applied Chemistry. In Turkey, there are about 50 different types of high schools. Turkey is criticised by other countries because of the great differences between what is said and what is really done. This criticism is also true and significant for high schools. As a result of this, in respect of the conditions of Turkey, the solutions should be found in the light of similar researches in High Schools.

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