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# Successful Experiences in Chemistry Teaching in Turkey



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## SUCCESSFUL EXPERIENCES IN CHEMISTRY TEACHING IN TURKEY

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### Abstract

*To create a student profile who is scientific literacy are one of the most common thing for many countries. Because of this reason, each country develop teaching program for them. Science teaching program is prior of them. Thanks to this science teaching which will be given an importance is given on scientific teaching, analyzing scientific knowledge and being a scientific literacy. Countries make some regulations according to their evaluation meetings. In 2000s, science teaching program was developed as taking base of constructivist approach. Then, some regulations were made according to this approach. In addition to this, some important changes were done in the program of science teaching in 2005. The first change was the changed name of the course. The name of the course was changed as Science and Technology. In 2013, science teaching program in middle school degree were revised. In these changes, argumentation and inquiry were taken as fundamental elements. In addition to this, studies and changed teaching programs which are based on constructivist approach were also seen high schools. Maintaining effective teaching programs is depend on Because of this reason, it is seen that teacher candidates take many pedagogic courses in their school years. With the help of these practices, teacher candidates are prepared to teaching environments. Moreover, it is necessary for taking education about new teaching approaches. When studies are examined, a benefit can be provided when teacher use methods problem based, project based, analogy, concept cartoon and technology effectively. Using these methods can provide benefit students' success, interest and motivation.*

*Growing individuals who can follow the rapid knowledge and changes is a necessity in our age. When the literature which is related to nature of science is examined, what scientific knowledge and how it occurs became an important issue. So, practices which are related to new approaches can be done in teaching environment.*

### 1.Introduction

It is seen that there are many studies which are related to science education. As examining the results of these studies, teachers and students can get knowledge about what kind of practices in teaching environment can be applied.

In below, some title and contents of some journals which are published in Turkey are given:

“Türk Fen Eğitimi Dergisi” (TÜFED): it published via internet a free journal one time in a year and every volume consists of two issues. Target group of the journal is science educators and students, teachers, individuals and instructions who serve products to education sector in the journal, scientific studies are published for target group the language of the journal is English and Turkish. ([www.tused.org](http://www.tused.org))

Eurasian Journal of Educational Research (EJER), is peer-reviewed journal published by Anı Publisher in order to contribute to science development with discussion of new ideas, information, innovations. Journal of the content is quality and continuous to cover all the sub-disciplines of education. The journal began own broadcast life when first number was published in March, 2002. (<http://www.ejer.com.tr/>).

TOJET, is international, interested in education technology and nonprofit electronic journal that is published four times (January, April, July and October) in a year. Presented article and research papers are published after evaluated by the editorial board. TOJET is indexed by international broadcaster: ERIC, British



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Education Index, Australian Educational Index, EBSCO ONLINE and EBSCO CD ROM Database ([www.tojet.net](http://www.tojet.net)).

Theory and Practice of Educational Sciences (Kuram ve Uygulamada Eğitim Bilimleri - KUYEB), is peer-reviewed journal published two times (May and November) in a year. KUYEB contain all areas of education related empirical/empirical research, reviews, the most recent literature studies, meta-analysis studies, model proposals, case presentations, discussions and other original writings. Studies full text or summary take place in EBSCO and indexed by Contents Pages in Education, Educational Research Abstracts Online ([www.edam.com.tr/kuyeb.asp](http://www.edam.com.tr/kuyeb.asp)).

İlköğretim-online (İOO) is international, interested in education technology and nonprofit electronic journal that has been published four times (January, April, July and October) in a year since January, 2002. İOO is an electronic journal, is only available on the internet. In addition, there is no printing. For now, access is free. İOO accept all areas of educational studies related with elementary education for publication. İOO aims to contribute production of knowledge about this field and disseminate the studies about the knowledge, theories, teaching qualifications, and any instructional design and technology about elementary education in disciplinary and / or interdisciplinary approach to education in Turkey (<http://www.ilkogretim-online.org.tr>).

In Vitamin's SüperVitt and MaksıVitt packets contain unlimited description of the subject, screen tests, English, Mathematics and technology course descriptions, preparation exams and rich content. These are very useful for Vitamin's students, with these contents, they can study their lesson with pleasure and this content provides permanent learning. Vitamin contains that in elementary education ; Mathematics, Science and Technology, Social Studies, Turkish, Atatürk's Principles and Revolutionary History, in high school; Physics, Chemistry, Biology, Mathematics, Geometry, Grammar and expression, History, Geography and English. ([www.vitaminegitim.com](http://www.vitaminegitim.com))

## 2. Students' basic capability and progress in chemistry education

When we examine the 2013 chemistry course general teaching aims in Turkey, it is aimed that chemistry literate person do following situations [1];

- 1) Students gain chemistry course's basic concepts, principles, modals, theories, law and skills. They can use this information for expressing to events in daily life, person health, industry and environment problems.
- 2) They can improve to manner for distinguishing the positive and negative side of human life. Besides, they evaluate to these aspect of human health, community, environment and life quality.
- 3) 3- Chemistry science and scientific knowledge the development process and understands; examines the factors that influence this process.
- 4) 4- Students are solutioned of data that are obtained with experiences; thanks to using information technology, this data are regulated, served and shared how with appropriate language of chemistry by students.

## 3. Examples of successful experiences

### 3.1 Experience

When we look that high school chemistry curriculum in 2013, Chemistry of Secondary Curriculum has consist both levels; basic Level and advanced stages which are prepared for 9. And 10. Grades firstly, 11. And 12. grades secondly. In basic level chemistry curriculum is provided that related to the everyday life of the individual however the details of a chemistry-free culture content for imparting. In advanced chemistry curriculum rich content is located that based on the chemistry of individuals drawn to occupations with the assumption that infrastructure concepts, principles, theories, laws and math-based applications.

In fundamental level, it is expected from students that gain some goals about scientific literacy as general, chemistry literacy as special. These goals are divided into subcategories, called as scientific "process skills" and "life skills". Chemistry course's learning- teaching methods accept to learning as special to person, having some common meaning structures between persons and affected from social environment. In the



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direction of this basic approach, teacher should arrange and conduct to learning - teaching methods in environment which environment enriched with tangible materials. For students who need to special education, basic level chemistry course teaching program should be assumed as supplementary resource. For that purpose, taking notice of every student's academic, intellectual, social, physical capacities, individualized education program (IEP) should be prepared [1].

In advanced level chemistry course teaching program foresee to observing students' learning process and evaluating to gained knowledge and skills with assessment and evaluation studies. If it requires, this learning activities will be changed. Evaluation studies to be held should be conducted simultaneously with course's aim- goals and teaching activities. In assessment and evaluations, it will be important that identification of students analytical thinking skills and observing of improvement. Together using of different instruments in evaluating student's achievement is important. It is offered that using the every instrument for the purpose of evaluating students' knowledge, skill and attitude [1].

Effective conducting of teaching programs depends on teacher candidates and teachers to know and implement skills about constructivist teaching methods. In this respect, it was grasped that teacher candidates took a lot of pedagogic content courses during the undergraduate learning. Teacher candidates get ready to teaching environment with committed applications. In addition to this, teachers should be informed and have education about the new teaching methods.

Using teaching technologies effectively by teachers is very important, because of that boost course's performance, learning result's quality, students' achievement, concern and motivation towards to course. It is determined that teachers who use teaching technologies, hold positive findings [2]. Multimedia supported course environment is important in chemistry teaching. Occurring of chemical events at a level of molecular complicates to chemistry teaching. A lot of students have difficulties in forming intellectual models when chemical process happens in a level of microscopic [3]. For this reason, a lot of research in chemistry education is stressed that use animations for improving intellectual models about abstract chemical formation, arranging misconceptions and smoothing to concept learning [4]. SEBIT who is founded by MEB for boost educational quality, contributes to teaching- learning process with technologies since 2007. Vitamin which is developed by SEBIT has content which absorbing, giving tangible examples for complicated concepts and directing to exposal. Proper visual and auditory materials were used in topic expression part for grasp to knowledge of curriculum easily. Students' pedagogical level took into account in every level. Vitamin aims that not only student's learn to science and technology, but also can research and scout. It helps to constitute classroom environment for providing student's active participation [5]. Kahraman and Demir aimed that examine to reforming level student's misconceptions regarding with topic of atom's structure and orbitals with computer supported 3D teaching materials. Study's sample comprises of 145 students who receive education in first class in science teacher training department. Atom's structure and orbital's topic was explained to experimental group with 3D Max 9 program and 3D picture, animation simulation and computer supported teaching method which was developed by researchers.

Besides, experimental group students performed an application in computer laboratory after every course. Control group courses conducted with conventional methods through two-dimensional pictures and animations supported methods. As data collection tool, open ended questions were used in the topic of atom's structure and orbitals. Findings stress that students have misconceptions about atom's structure and orbitals. According to data which held later the applications, in arrangement of misconceptions which appear in achievement pre-test, computer supported teaching is more effective than conventional method.

Grown scientific literates who are competitive, kept pace with new technologies and followed new information, is necessity of our modern era. When we examine the literature which is related with nature of science and science education, what is scientific knowledge? how does it construct? And how can we teach these? Questions are really important.

In researches which examine teacher candidate's and teacher's understanding towards to nature of science, it is revealed that these groups have a lot of misconception about the nature of science [7,8]. If we want to learning to nature of science by students, teachers should assimilate to nature of science. For this reason, recently, a lot of studies are done for improving and determining teachers' and students' understanding





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about nature of science. For constructing productive learning environment about nature of science, it is required that student's should work and gain data like scholar and should participate in predicting and supporting, discussing studies. It is known that curriculum, educator and student's parents want to grow their children with interrogator and reviewer manner. Growing the children as open minded and sceptic is very important in the world. From this point of view, argumentation based method is proper to constructive method for science teaching. When we examine the argumentation context, it is a method that based to interrogation, suspecting, analysis. It is the basic standard of argumentation that doing activities for improving students' skills towards to hypothesizing and testing to hypothesis. We present to Toulmin's argumentation modal (Toulmin, 1958) in the following [cited:9].

When we look to researches, it is identified that teacher candidates gained positive manner towards to argumentation. Besides, teacher candidates expressed that argumentation is very effective for gaining scientific thinking and interrogation skill in chemistry teaching, supporting meaningful learning and conceptual change, improving the understanding about nature of science, keeping the interest alive towards to course and supporting students to join learning process [9]. Students can participate in argumentations about nature of science and can gain experience. In Aydın's and Yılmaz's [10] study, they examined teacher candidates' understandings improving based on argumentation about nature of science. They formed an environment which students can discuss about argumentation experience as personal and small groups can make an inference about argumentation in science education. In the other example which was done by teacher candidates Rutherford and Thomson, they gained similar results in experiments of alpha particles' scattering, but, for explain their remarks they understand for explain the same observations, putting forward different hypothesis. It is focused in the activity that how belief and prior knowledge affected to interpreting to data, how argumentation use for affect to science sphere to valid assentation, effects of social-cultural factors in constructing process of knowledge. In the end of research, it is understood that chemistry teacher candidates have effective progress and changing. Argumentation in chemistry education positively affected to change of scientific knowledge, social constructing and creativity.

Inquiry-based learning approach is frequently used in chemistry education which is containing constructivist approach. Inquiry-based learning approach has been known as if a process how the creation of problem situations, make researches, as analyzed information. For this reason, we can see that student-centered learning and learning by experience are supported by this approach. Also, the ability to generate hypotheses and data identification skills is developed by inquiry-based learning activities. Generally, in this process, 5E learning model is used. This model has five levels such as input, discovery, description, expansion and evaluation [11]. In this model, in terms of the basic features of the steps it is possible to summarize.

- Engage: In this step, thanks to discussion condition or a short activity attention of students is drawn, thoughts of students are actuated, to new concepts are directed with old information.
- Explore: In this step, concepts are discovered how making observations, recording data, designing experiments and developing hypotheses.
- Explain: Under the guidance of teachers, students are explaining concepts which are explored by students; results are generalizable with use of principle and models.
- Elaborate: Information is expanded and information is adapted to the new environment by students.
- Evaluate: Students and teachers are rating some concepts which are explored by students [12].

When we research examined, we can see that scientific process skills and type of scientific process skills which are used by students are increased. Also we can say that science and technology lessons are saw more fun by students [12]. In a survey Temel and others [13] researched that effect of learning cycle model over students' level of the comprehension about reduction and oxidation. In addition, they researched that effect of this model over lower and higher level thinking skills. The sample group consists of 30 science teachers. In studies of teacher candidates before the application of the learning cycle model, especially in the lower-order thinking skills in the pre-test measure they can answer the questions correctly, that measure higher-order thinking skills questions they could not answer the fully revealed. Although oxidation-reduction of the subject in everyday life quite a lot of application area, we can say that the issue is quite abstract being, teachers these issues while learning rote learning are turning and daily living necessary connections theory





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patches and fixes them inadequate to understanding and the low level of understanding to have to cause. Therefore there will be future teachers, we can offer especially teachers that they have insufficient understanding of the remedy; the issue of the establishment of links with everyday life should be able to develop higher-level thinking skills.

Analogies are one of the other methods in chemistry education. Analogies are often misconceptions are the preferred tool for troubleshooting in science education. Analogy, starting from a known concept is to find the unknown concept. There is a link between known and unknown. These links likening one thing is something else, a story or manner using or by doing experiments can be established [14]. Analogies which are an important teaching and learning tool Ekinçi, Planters and Aydın [15] the learning and development of scientific ideas and concepts have been suggested to play an important role. When examining the research, the use of analogies, besides increasing student success is observed in removing misconceptions about the revealed positive results [16].

In Turkey, prepared according to the constructivist approach high school chemistry curriculum has been implemented from the year 2008-2009. Chin and Chia, constructivist learning theory learning and teaching process, one of the reflections of Problem Based Learning (PBL) is defined how students focus on real life problems and actively participating in the learning process of learning to perform in order to solve the problem [cited.17]. PBL is encourages to students identify problems and to develop an alternative perspective, encourages creative and critical thinking. Kuşdemir and others [17] in a study which 52 units in his study with the participation of Grade 10 students have examined that unit in chemistry for students the effects of in mixtures achievement, attitude and motivation. In this study, students involved in the study with a random sampling method, including experimental and control groups and this groups were divided into two groups. In the experimental group "mixes" unit was treated with problem-based learning model. Otherwise the same unit in the control group was treated to traditional model. In both groups have 9 weeks for processing. In study, for collect the data, achievement test, chemistry attitude scale, motivation scale and student interview form was used by researcher.

The results obtained from this study and the statistical studies, PBL 'are students' attitudes towards chemistry, chemistry issues and their motivation towards learning achievements in chemistry reveals that a positive impact. On the basis of the constructivist approach to science teaching program up by revision has increased that active participation in learning environments that provide students' course work on visual tools. One of the methods in question is the concept cartoons. Concept cartoons which are used in science education has emerged contemporary, innovative and student-centered method.

Result of the use of concept cartoons in science classes we can expect that students concentrating their attention to the lesson fun, images, and can discuss their views of learning and knowledge create configuration environment [18]. Concept cartoons consist of both use of visual stimulus and some texts which are in the form of speech and in the form of cartoon include some drawings which are reflecting events from everyday life [19]. When the research examined we can see that the concept cartoons with existing experiences of the students, they encounter new information inquiry, helping students in this direction has been determined that positively affect perceptions [19]. The result of one of the other survey, modular instructional design concepts used in the cartoon is positive related to the students' opinions and concept cartoons positive impact on learning is determined that provides the motivation [20].

Students and teachers learn together must be a structure how can be executed with success teamwork, problem solving skills, learning, and they assume the role of teachers and student researchers with more in the center. Students gained knowledge and skills that they can transfer legislative day, every day can be used for solving new problems they encounter have a structure which is considered the most appropriate method of teaching is one of the project-based learning methods [21,22]. Project-based learning is provide an understanding of the power how it is variable, relative and rapidly increasing knowledge, extremely limited time zones, technology-based learning environment and the individual, problem solving skills, analytical and critical thinking, research, may decide, taking responsibility and cooperation can work in an individual will make form enables us to [23]. Project-based learning, addressing the diversity of all students and is an excellent way to provide meaningful learning [24]. Project-based learning approach is an approach with an



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interdisciplinary approach. Students can find the opportunity to develop a combination of skills participating in projects and projects by implementing the language of mathematics, art history, from science to technology in all areas [25].

### 3.2 Evaluation of experience

In general, students in the successful application of the following conditions is observed that the emphasis for the development;

- Students in correcting the misconceptions and concepts to facilitate teaching.
- Students are able to undertake research and discovery.
- Students can develop positive insights into nature of science.
- Students can be tested to develop the ability and hypotheses.
- Development of students' scientific thinking and questioning skills.
- Ensuring active participation of students in the learning process
- Development of students' learning by doing
- Students develop the ability to connect with everyday life.
- Students of abstract concepts embodied in facilitating
- Development of students' higher-order thinking skills
- Students' ability to communicate in to access information from known to unknown.
- Development of students positive attitudes and motivation to chemistry education

## 4. The Impact of the Project on Successful Experiences

### 4.1 Workshop

The workshop about successful experience was held in Education Faculty of Kırıkkale University in 2th April, 2014. Murat Demirbaş, Abdullah Anıl Hoşbaş, Erdem Hareket, Elif Tuğçe Karaca, Ömer Faruk Şen, Nazmiye Başer, Şengül Akıncı, Hüseyin Miraç Pektaş, Nilgün Solak, Tuğçe Aydın, Merve Aydoslu were attended the meeting. It was mentioned to get students to have scientific understanding so that they can be scientific literate individuals. Moreover, it was argued that the weak parts of the recently developed and applied science education program. In order to use science education program efficiently, teacher have to use new teaching approach.

It was discussed how to use concept cartoon for effective science teaching and also sample of cartoon maps were criticized. Moreover, it was emphasized that new analogies had to use effectively in science teaching. It was explained that conceptual learning would be more meaningful. It was underlined that laboratories had to be use in chemistry education in a effective way and also it was important the type of laboratory activities which got student to be active had to be selected. Moreover, it was said that content of science teaching had to be connected with daily life experience while science teaching activities. On the other hand, using multimedia and computer materials gave student opportunities to have meaningful learning. The meeting was concluded with the example activities of solution recommendation about science teaching.

### 4.2 Testing of ICTs

The 3dMolSym (<http://www.chem.auth.gr/chemsoft/3DMolSym/Index.htm>) applications taken place in website of the effective use of teaching material were selected. The applications consisted of chemical reactions, chemical structure of the molecules, the molecules off the formula, bond structure, symmetry drawing. After using the application science teacher candidates:

- Drawing molecular symmetry structure
- Showing the bond structure
- Observe the molecule structure in 3D and doing sample activities
- Determine the closed formula of molecule





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The content in used the study:

- There are activities to show the molecule structure in 3D
- Student can show the properties of the molecules with constructing 3D shape of molecule.
- There is so much detail information about molecule structure.

18 science teacher candidates in Education Faculty of Kirikkale University in 2013-2014 teaching years participated in the study.

The study was carried out mainly in the following steps.

- Firstly, teachers are given information about the work to be done.
- 3D simulation program are examined, 5 open-ended questions was prepared as a measuring tool. This measurement tool was given to students as a pre-test before the study and then 3D simulation software and applications have been used.
- Some formula of molecules, bond structure and symmetry properties were investigated.
- Students had the opportunity to practice them in their computers.
- At the end of the study, the measurement tool has been applied as a post test.
- Results were compared between the two applications.
- In addition, students are opinions about the application also given in the study.

It was clear that there was a positive result of 3D activities in creation of closed formulas of molecules, bond structure and drawing symmetry of molecules when the result was criticized.

The opinions of students about the activities;

- Remind old information (2 students)
- Chemistry is useful to learn (students)
- Embody the topics (4 students).
- Visualize the subject (9 students)
- Provide practice. (1 students)
- Provide easy to understand (7 students)
- Provide permanent learning (6 students)
- Show mistakes. (8 students)
- Provide feedbacks (5 students)

Teacher candidates stated that they liked 3D applications; it helped to better understand the content. Also, they expressed hat student could get meaningful understanding with use of 3D applications.

## 5. Results

Science education programs in each country renews every day for effective teaching. Different teaching approaches are given place in education programs with the result of recently applied studies. In Turkey, it is seen that done a lot of work in this area. The teaching approach which made meaningful learning takes place in the studies. Students in chemistry lesson are required to exhibit the behavior which:

- Have a positive attitude towards chemistry course
- Have Basic level of background information for chemistry courses
- Have science process skill
- Work in a group efficiently
- To be responsible
- Have a positive attitude towards the nature of science

In this regard, many the implementation of new teaching methods are used in the academic environment, the results are analyzed. One of them is the application of computer-aided teaching chemistry in practice, students can be found in effective learning environment with simulations while using computer based activities. Moreover, students put forth the grounds to prove their ideas in argumentation based application. Therefore, Students will be able to understand how to construct scientific information. Students are actively involved in scientific studies in inquiry based teaching. Also, students perform a more permanent conceptual



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learning with the use of analogies in teaching. With Project-based teaching practices and students can work on projects and they can construct new designs.

It can be stated that the teaching method based on constructivism could get students achieve meaningful learning. It is clear that there are affective result of using 3D simulations teaching materials which developed in the project in the chemistry teaching. Therefore, the activities that makes student to be active in lesson are required. So, planning of in service teacher training program effectively ensure the desired level of education.

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