Education and Science

Vol 42 (2017) No 192 327-348

Development of an Instructional Material for an Enriched Book Relating to "Interactions between Chemical Types" Unit in The Ninth Grade Chemistry Curriculum and Investigation Its Effects *

Fidan Hakkari [1], Turgut Yeloğlu [2], Cengiz Tüysüz [3], Nail İlhan [4]

Abstract

In this study, an instructional material for enriched book (en-book), relating to "Interactions between Chemical Types" unit in the ninth grade chemistry curriculum was developed. For this purpose, the effect of the material (en-book) on pupils' chemistry achievement, attitude towards chemistry and technology, motivation towards the instructional material were investigated. In the study, a quasi-experimental research design, pre and post-test experimental group model, was used. The research was conducted with 226 ninth grade pupils, 112 of them as control group and 114 as experimental group, attending four different classes in two high schools in which a pilot study called FATIH (Movement to Increase Opportunities and Technology). The project was implemented, in Hatay in spring semester of the 2014-2015 school year. Random cluster sampling method was used to select the sample groups. Lectures were carried out by traditional methods mostly by using board, course books etc. for control group and by en-book for experimental group. The data were analyzed with SPSS (version 22.0). Descriptive analysis, independent groups' t-test, Analysis of Covariance (ANCOVA) and Multivariate Analysis of Covariance (MANCOVA) methods were performed to analyze the data. According to the results, there has been a significant different between both groups chemistry academic achievement mean scores in favour of experimental group (p=.000). Post-test scores from the Chemistry Attitude Scale (CAS) demonsrated that there has been a significant different between attitude towards chemistry of both groups in favour of the experimental group (p=.001) and the en-book has positively contributed to pupils motivation. The results of the study also showed that there has been no statisticaly significant difference in the attitude of control and experiment groups towards technology (p>0.05).

Keywords

En-book

Achievement

Attitude towards chemistry

Attitude towards technology

Motivation towards instructional materials

Article Info

Received: 06.15.2016

Accepted: 09.29.2017

Online Published: 11.12.2017

DOI: 10.15390/EB.2017.6690

* This article is derived from Fidan Hakkari's PhD dissertation entitled "Development of an instructional material for an interactive book relating to "Interactions Among Chemical Types" unit in the 9th grade Chemistry curriculum and investigation its effects", conducted under the supervision of Turgut Yeloğlu.

[1] Mustafa Kemal University, Kırıkhan Vocational School, Turkey, fhakkari@mku.edu.tr

[2] Mustafa Kemal University, Faculty of Arts and Sciences, Department of Mathematics, Turkey, turgutyeloglu@gmail.com

[3] Uşak University, Faculty of Education, Department of Mathematics and Science Education, Turkey, ctuysuz@gmail.com

[4] Kilis 7 Aralık University, Muallim Rıfat Faculty of Education, Department of Mathematics and Science Education, Turkey, naililhan@gmail.com

Introduction

The "information" and "communication technologies" being claimed to be at the center of technological developments, which are also related to globalization are presently seen as the upcoming sign of a society known as information societies (Yılmaz & Horzum, 2005). The hike in the production of information and the development of technology has led to many innovations and possibilities in terms of the access to information. In particular, recent developments in internet and computer technology have resulted in many radical changes in education system as it has also happened in all fields (Odabaş, 2003).

The technological products which are used in the sphere of education make it easier to transfer the information to the educational environment. Due to the fact that the internet was began to be used in the zone of education, there revealed many solutions to solve some educational problems that could not be solved until then (Opportunity to reache and share information more quickly by internet technology and offer equal education opportunities for people) (Bozkurt & Bozkaya, 2013). In addition to old models, today many contemporary methods have been started to be applied to realize more efficient and productive education results (Odabaş, 2003). Indeed, owing to this many macro level national projects are started to be implemented around the world, which are mainly based on providing computers for many schools and training centers in which thousands of teachers exist. One of the most known titles among these projects is the project called "Movement for Increasing Opportunities and Improving Technology (FATIH)", which was started to be implemented in 2010 for Turkey. FATIH Project, first of all, has an objective on bringing the needed equality of opportunities in education, and increasing the quality of education by using technology effectively in schools, most specifically at pre-primary, primary and secondary schools of Turkey. It is also the largest and most comprehensive education movement, which was put into praxis in the world with the establishment of a smart board interactive system in the classrooms, and supported by a provision of internet network structure via sustaining the equal distribution of tablet computers to pupils and teachers in an interactive manner (Akıncı, Kurtoğlu ve Seferoğlu, 2012; Ministry of National Education [MONE], 2011). Moreover, the electronic base contents involved in this project; i.e. en-books etc., are mainly designed in an aim to be used in other compact or comprehensive materials or tools such as electronic books (e-book), interactive e-book, video, presentation, animation, electronic exam (e-exam), interactive maps and tablet PCs and all other multimedia supplementary tools. The aforementioned tools were to be chosen previously in a perspective to consist of information objects and learning objects as well.

Nowadays, the improvements, innovation and developments in technology sphere have also resulted in the upcoming need to reorganize the education system. Especially in the mid-1990s, the concept as e-learning, which is a type of learning being independent of time, space and also used by the development of asynchronous discussion groups with world wide web and internet, sustained that learning could be more efficient by using internet tools, and plus also enabled the needed information to be reached by wider groups and even masses (Üzel & Özdemir, 2012). It also fits the need of individuals to learn life (Bozkurt, 2015). Accordingly, Strommen (1992) and Demirli & Dikilci (2003) also stated that, it might be a hope for meeting the individual needs of learners in education, because it is motivating them to learn, and providing a learning-teaching environment for different ages and support the developments in the use of electronic environments. Hence, the content development studies in the electronic environment have become inevitable today, and naturally e-course, e-book concepts have taken a significant place in the literature. Indeed, many e-learning platforms are being used in many schools, especially in higher education. This made it possible that pupils could participate in online classes and access course material. The creation of effective, interactive, rich and individualized content in e-lectures became an important factor in improving the efficiency and quality of the course. Currently, the studies on content development and internet based teaching in e-course applications has not yet been fully standardized around the world. However, the attempts on developing contents and different methods are gradually being developed, thanks to new searches (Albayrak, Kültür, Erden, & Tonguç, 2003). The attempts on this is being continued in order to design and develop new instructional management systems (Moodle, Mooc, etc.) that can be easily accessed and used by different content design products (e-book, en-book).

According recent researches, the multimedia enriched courses can increase the success of the pupils via their higher comprehension and persistence about content (Arıcı & Dalkılıç, 2006; Karalar & Sarı, 2007; Güzeller & Korkmaz, 2007; Emrahoğlu & Bülbül, 2010; Daşdemir & Doymuş, 2012; Rusanganwa, 2015; Zahra, 2016). Being a solid reason for this, it can be said that the multimedia tools can appeal to both our eyes and ears. In this context, Paivio (1986) developed the Dual Coding Theory upon this dimension. As to this theory, all words and images are going to be stimulated independently of each other, and then the presentable information is to be coded separately in a long term memory. Indeed, this makes it easier to understand and remember the information for pupils. In this respect, by the materials designed in the computer environment, all the information structures for the pupils are going to be provided in an easier way. Moreover, the textbooks supported by e-books (electronic book) and en-book (enriched book) supported by multimedia tools literally passing through the Fatih Project are now in a stage to be left. Instead, the interactive books in the literature are referred to as an upcoming term as interactive e-books and en-books recently (Embong, Noor, Ali, Bakar, & Amin, 2012; Mitropoulou, 2012; Bozkurt & Bozkaya, 2015; Nguyen, 2015; Özer & Türel, 2015).

Electronic book (e-book); is a copy of a book in digital form, generally in pdf, doc or txt format, can be read via computer, e-book reading devices or portable devices, or is the content that is written directly in electronic form (Soydan, 2012; Özer & Türel, 2015). En-book is essentially a digital book which is designed for touchscreen. In en-books, the content is generally enriched using text, picture, image, sound, animation, three dimensional objects or other multimedia elements, thus the user interacts with touching the content, in which many communication channels can be used together (Itzkovitch, 2012; Bozkurt & Bozkaya, 2013). The Ministry of National Education (MoNE) also defined the en-book as "a textbook approved by the Turkish Board of Education (TTKB) and according to this, it is enriched with multimedia materials without any changes to textbooks written on PDF format" (MONE, 2011). While en-books are called "interactive e-book" in studies made abroad (Hwang, Sung, & Chang, 2016]; Mitropoulou, 2012), they are called interactive books, interactive e-books or z-books in Turkey (Bozkurt & Bozkaya, 2013; Özer & Türel, 2015). Indeed, en-books are designed for a specific attempt to transfer knowledge, thus direct and help pupils to transfer the needed content to the final users. In praxis for en-books, not only the book but also the user are always active and a mutually involved in a rich communication process. As it is aforementioned, those books and obtained communication are brought at a higher level of communication and interaction which gives the learners flexibility in many manners.

The aimed users of the FATIH Project are also a vital point in which the primary and secondary pupils should be considered. Indeed, this application is mainly used for the first time in primary education in en-book studies, and naturally there always exists a sample page to be prepared at the point of accessing the multimedia extensions of the related pupils. Therefore, Sarıtepeci and Yıldız (2013) have also conducted many studies to measure the usability about the effectiveness in designing and using an en-book for Social Studies courses of which content was previously prepared by the Ministry of National Education. In this study; video, banner, picture and other items were analyzed. According to the results, it is seen that it wouldn't be possible if anyone wants a direct access on any page within the en-book without selecting any unit or subject (parentheses apply), so the pupils might not find the necessary options in the related page recording applications. The main problem on accessing the linked page is derived from the fact that it is mainly a flash based system. Hence, the unattached item such as videos can't be attracted to the content in the page, and then this becomes one of the biggest deficits in the game activity for en-books, being not included in any direction.

In the related literature, it is witnessed that en-book technology is firstly used by MoNE and Anadolu University in Turkey. It contains all the programs which were taught in Anadolu University's open and distance education faculties for business administration and economics. Today, Anadolu University's Interactive e-Book Project is also the most comprehensive en-book project in Turkey, recalling its content hosts and the number of lessons in the open education system. Under the scope of the project 340 en-books were prepared to be shared (Erorta & Kayabaş, 2015).

Looking at a different study conducted in Turkey, the opinions of the pupils about the en-books which were developed for the courses of information technology and about the steps and strategies of the ARCS motivation model for the university pupils were taken into consideration. It was seen that the participants had emphasized the most favorite page design having had a strong direction in the designed en-books, yet they also pointed out that there were many unnecessary texts as weaknesses (Varol, Özer, & Türel, 2014). In another study, some prospective teachers of information technology were examined about their perceptions of e-books and en-books through using metaphor analysis. Looking at the developed metaphors related to the research e-books, the very first and favorite one was defined as the superiority of the en-books being an e-book, having the metaphor of "appealing to multiple senses" (Özer & Türel, 2015).

Çınar and Akgün (2015) also designed a hybrid course book pilot study with texts, visuals and augmented reality augmentation. This study aimed to scale the success about teaching 'at the fair' unit in the 6th grade English course contents of all the middle school curriculum so that the contents related to this subject could be displayed more visually and audibly. As a result of evaluations of experts, educators and pupils related to the presentation of the prepared books and their contents, there revealed a source in order to set an example in the finalized fields.

In spite of these ongoing advances in information technologies, the inadequacies of both hardware and content might cause that the objectives could be far behind. In an evaluation report, which was prepared by discussing with 17 pupils, teachers and parents, it was also stated that those projects positively affected the education-training but there were revealed generally many serious system related problems (Çifçili, Sertelin, Emir, & Kahveci, 2012). It was plus emphasized that there exist many other serious problems in terms of usability and functionality of system, especially about regarding the used system. Those serious problems appear in creating content, moving these contents to e-learning platforms and bringing pupils to these contents. In addition to this, many researches on this project also show that teachers could rarely use their computers in education, sometimes (Kayaduman, Sırakaya, & Seferioğlu, 2011). The lack of sufficient content in the FATIH project, today, remains one of the major shortcomings of the project (Pamuk, Çakır, Ergun, Yılmaz, & Ayas, 2013). The recent introduction of the en-book concept into the literature also shows the necessity of this work, especially in the field of academic studies for primary education, and about the limited presence of foreign resources (Shamir & Shlafer, 2011; Mitropoulou, 2012; Tania & Fadiawati, 2015; Ebied & Rahman, 2015). Along with this study, it is aimed to eliminate these deficiencies and to determine their effects by related analysis. Following this target, it is questioned herein if there is any impact on pupils' academic achievement, attitudes towards chemistry lessons and technology, or motivation for teaching materials, via the material developed about 9th grade chemistry lesson for en-book use in pilot schools in FATİH project in Hatay province, or not. The answer was sought in order to conduct this study.

Answers were sought to the following sub-problems depending on the research problem mentioned above in this study.

Sub Problems:

1. Is there any statistically significant difference on CAT scores average depending on the implementation method between experimental and control group pupils after the application.
2. Is there any statistically significant difference on CAS scores average depending on the implementation method between experimental and control group pupils after the application.
3. Is there any statistically significant difference on PATT scores average depending on the implementation method between experimental and control group pupils after the application.
4. How does it affect ninth grade experimental group pupils' motivation towards chemistry teaching materials developed for en-book?

Method

Research Model

In this study pretest-posttest control group quasi-experimental research design has been implemented to examine the effects of en-book which has developed relating to "Interactions between Chemical Types" unit in the ninth grade chemistry curriculum. And it is investigated whether there is an effect of the material on pupils' chemistry achievement, attitude towards chemistry and technology, motivation towards the instructional material. In this model, there are two groups which are randomly assigned. One of them is control group and other is experimental. Measurements are made before and after experiment for both groups. The pretest of model helps to know the degree of similarity of the groups before the experiment and help adjust results of post tests acording to pretest result (Karasar, 2012). Control group followed the regular instruction outlined in the teacher guide of the Ministry of Education. The research model is given below.

Table 1. Quantitative Research Design

Group	Pretest	Process	Posttest
Experiment Group	CAT, CAS and PATT	En- Book	CAT, CAS, PATT and IMMS
Control Group	CAT, CAS and PATT	Regular instruction	CAT, CAS and PATT

CAT: Chemistry Achievement Test
CAS: Chemistry Attitude Scale
PATT: Pupils Attitudes Towards Technology
IMMS: Instructional Materials Motivation Survey

Study Group

The universe of this study was ninth grade pupils of two pilot high schools of the FATIH Project in Antakya during the second semester 2014-2015 school year. The sample of the study totaly consists of 226 pupils in these schools, selected by cluster sampling method on four different nineth-grade classrooms, 112 pupils from control group and 114 pupils from experimental group. Ninth grade classes that has been formed already has been recognized as cluster.

Experimental Group Material and Making Application

In this study, for implementation of the en-book for the experimental group, first animations were designed by the researchers. The reason of choosing the "Interactions between Chemical Types" as the cemistry subject for designing animations and en-book was including more abstract concept and being a one of the most difficult issues to understand (Yayon, Mamlok-Naaman, & Fortus, 2012; Şen & Yılmaz, 2013). It was thought that the effect of en-book could be examined better in such a case. According to studies; presentation of macroscopic chemical events through multimedia tools such as simulation, animation, video facilitates pupils to understand abstract chemistry events (Pekdağ, 2010; Tüysüz, 2010; Kamtor, 2016; Duman & Avcı, 2016; Herga, Čagran, & Dinevski, 2016). Presenting such multimedia tools together by en-books provide privatization of education according to the individual. For this reason, it was decided to enrich the subject with animations and videos. In the process of designing the animations, first the topics that were difficult to understand were identified. Later, the subjects determined by the instructors in the field of chemistry were explained to the animation designer, and the formation of the chemical phenomena in the topics was explained by drawing the shapes. These draws were used as storyboard by designer. 24 animations (only appearance and formations can be observed) were designed about "Interactions between Chemical Types" unit in the ninth grade chemistry curriculum located ions, their molecular appearance, formation, and the bonds formed between them by a flash animation program. In addition, an opportunity was given to the pupils to make experiments by the interactive animations. So four lab applications were designed in this unit. Animations, after the necessary rearrangements were made, were completed in accordance with the ideas and suggestions of two instructors in the field of chemistry training and a chemistry teacher. At

the same time, it was enriched by the support of the videos related to the topic which was already prepared by Ministry of Edcuation EBA (Education Network Computing). The prepared animations were embedded as pdf format by using Adobe Reader XI in the relevant sections of the third unit in ninth grade chemistry textbook prepared by the Ministry of Education.

While en-book was used for the experimental group during the course, the conventional teaching method was carried out for control group, via drawing the chemical events on board by the two chemistry teacher in both schools. They used board and textbook during lecture. The teachers firstly explained the lesson then solved the problem and reinforced the subject. Sometimes they asked pupils questions during lectures. Despite having smart board in classes, they have not used yet because of the lack of en-books and digital material in the year of the practice. In addition, the distribution of the tablet has not been realized yet. For this reason, the use of en-books was not mentioned to the pupils in the control group. In traditional teaching, the subject was primarily taught by the teacher. Afterwards, the questions about the subject were solved and the subject was reinforced. Experimental and control groups were randomly assigned to the study groups.

Lectures were carried out by chemistry teachers of each school with close level of professional experience for experimental and control groups. Before starting the application, all scales were applied on all groups as a pre-test. The courses carried out by the prepared training material (en-book) in 2014-2015 academic year, starting from the second week of February, 2 hours per week and a total of 8 weeks in the computer labs via installing it pupils' computers as well as the smart board.

For making a prepared laboratory application in the course, primarily an illustration of instructions emphasized to pupils which they needed to follow. The sample application which was displayed on the smart board has suffered without mouse clicks. But the pupils did not have any problems because they could perform the application on the computer. Before beginning the experiment, pupils were informed by teachers about the purpose of the experiment, and then teachers gathered attention of the pupils by asking questions about what is to be expected at the end of the experiment. While pupils were performing the steps by following the instructions, teachers corroborated the information relevant subject with experiments. Besides, before showing animations of the formation of chemical bonds, the teacher first discussed with the pupils about what kind of bond these elements would be made then animations were executed to provide the pupils testing their predictions. Thus, this provided interaction between the material-pupils and teachers -pupils. In order to corroborate the subject they have learned amusingly, picture matching game (chemical bond type and bond name is matched) added at the end of the unit. In this way, information about the visual bond structures has been structured. 8 weeks later, the same tests were applied to the pupils as post-tests by the same teachers. 8 week was enough for eliminating the effect of pre-test. So as not to lose any data the pupils were asked to write their names on test papers. The pupils, who did not go to pre-test, post-test scores were also canceled. In this way, the internal validity of working was provided.

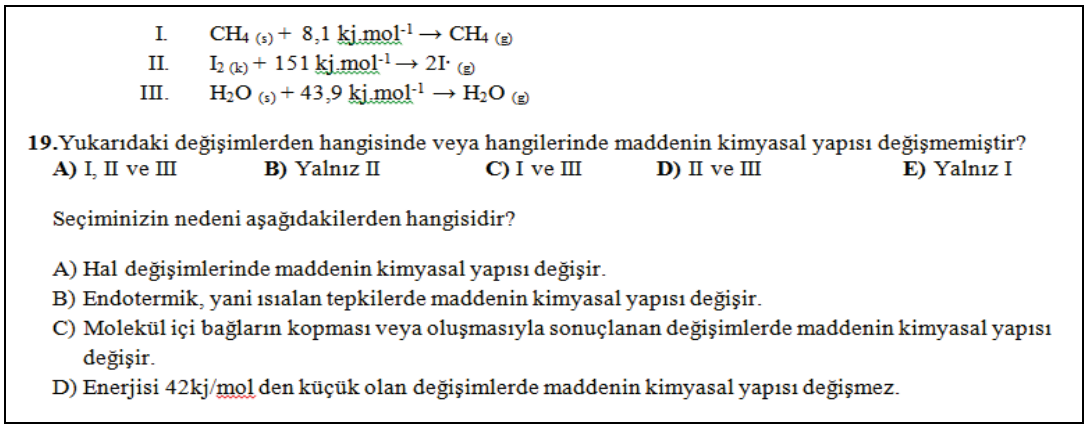
Animation, video and page examples used in the en-book are given in Appendix 1 basis on topic-by-topic.

Data Collection Tool

With the aim of data collection; Chemistry Achievement Test (CAT), Chemistry Attitude Scale (CAS), Pupils Attitudes Towards Technology (PATT), Instructional Materials Motivation Survey were used.

Chemistry Achievement Test (CAT): Pre-test was applied to determine the readiness of pupils about "Interactions between Chemical Types" unit in the ninth grade chemistry curriculum, post-test was applied to all pupils in order to determine whether there was any difference between the groups depending on the applied method.

CAT was developed under the study of "Test Development Course" as the two-tier multiple choise test by Aktaş (2014). To determine the validity and reliability of the achievement test, a pilot study was administered with 208 ninth grade pupils. The reliability of KR-20 value of the test was 0,788. The average difficult index of the test was calculated as 0.47. This indicates that the test was medium difficulty. Discrimination of the test was calculated as 0,51. As it is near of discrimination power which was desired 0.50, it can be said that the test was quite distinctive. The highest score that can be taken from test is 21, the lowest score is 0. Here is an example question of the test shown below (Figure 1).



I. $CH_{4\,(s)} + 8{,}1\ kj.mol^{-1} \rightarrow CH_{4\,(g)}$

II. $I_{2\,(k)} + 151\ kj.mol^{-1} \rightarrow 2I\cdot_{(g)}$

III. $H_2O_{(s)} + 43{,}9\ kj.mol^{-1} \rightarrow H_2O_{(g)}$

19. Yukarıdaki değişimlerden hangisinde veya hangilerinde maddenin kimyasal yapısı değişmemiştir?

A) I, II ve III **B)** Yalnız II **C)** I ve III **D)** II ve III **E)** Yalnız I

Seçiminizin nedeni aşağıdakilerden hangisidir?

A) Hal değişimlerinde maddenin kimyasal yapısı değişir.
B) Endotermik, yani ısıalan tepkilerde maddenin kimyasal yapısı değişir.
C) Molekül içi bağların kopması veya oluşmasıyla sonuçlanan değişimlerde maddenin kimyasal yapısı değişir.
D) Enerjisi 42kj/mol den küçük olan değişimlerde maddenin kimyasal yapısı değişmez.

Figure 1. Example Question of Chemistry Achievement Test

Chemistry Attitude Scale (CAS): Chemistry Attitude Scale was used in order to determine whether there was any difference between both groups pupil's attitudes towards the cemistry course. CAS developed by Cheung (2009) in order to determine high school pupils' attitudes towards chemistry and it was adapted into Turkish by Şenocak (2011). Chemistry Attitude Scale was applied to all pupils in groups as pretest and posttest. Seven-point likert structure was used in likert-type scale which totally consist of 12 items. According to researches, giving more reliable data was the reason of using seven-point likert scale (Alwin & Krosnick, 1991). Cronbach's alpha reliability co-efficient of analysis of the data obtained in this study was equal to 0.91.

Pupils Attitudes Towards Technology (PATT): PATT was used in order to determine whether there was any difference between pupils of both groups attitudes towards technology. PATT was developed by Bame, Dugger, de Vries, and McBee (1993), based on 58-point Pupils Attitudes Towards Technology scale then it was adapted to Turkish by Yurdugül and Aşkar (2008) as 24 items with 7 point likert scale. Attitudes Towards Technology Scale is consist of 4 sub-dimension as Tendency to technology (TT) , Negativeness of technology(NT), Importance and contributions of technology (ICT), Technology for all (TFA) (Yurdugül & Aşkar, 2008). Cronbach's alpha reliability co-efficient of analysis of the data obtained in this study was equal to 0.81. The test consisted of 24 items with fifth likert scale.

Instructional Materials Motivation Survey (IMMS): Instructional Materials Motivation Survey was used to determine how and how much the instructional materal that pupils have practised motivated the experimental group pupils. ARCS Model of Motivation, "Instructional Materials Motivation Survey" was developed by Keller (1987c) and was adapted to Turkish by Kutu and Sözbilir (2011). It consists of 4 componenets as attention, relevance, confidence, satisfaciton (Keller, 1987a, 1987b). These categories include the conditions necessary for the individual to be motivated (Keller, 2000). The fact that the ARSC Motivation Model is the result of the combination of motivational and instructional design theories allows this theory to be used comfortably in teaching design studies (Balaban Salı, 2003).

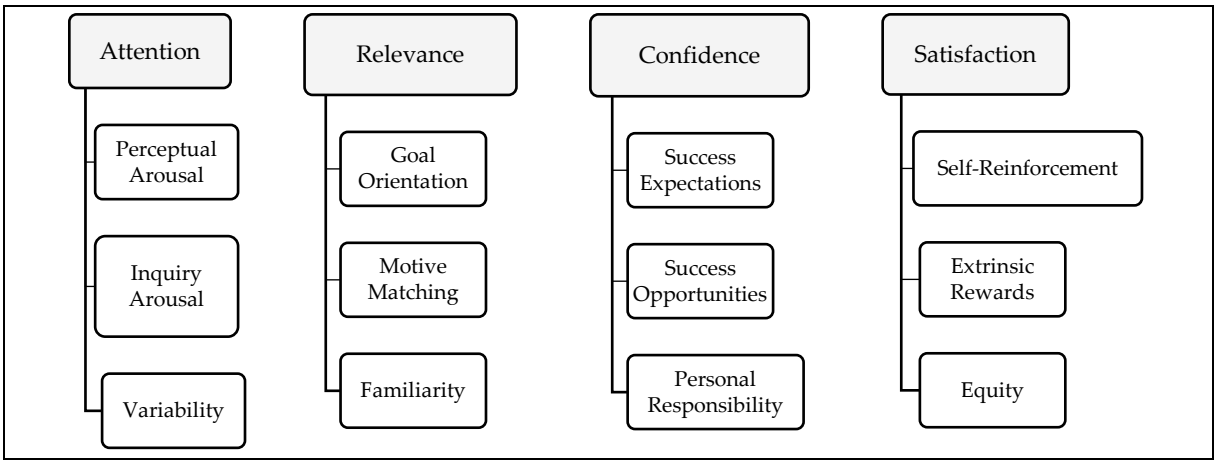


Figure 2. Major and Sub Categories of The ARCS Model

This scale determining the effects of the instructional materials on high school pupils' motivation, consists of 24 items. 5 point likert rating scale was used as "strongly disagree" (1), "disagree" (2), "somewhat agree" (3), "agree" (4), "sstrongly agree" (5). Cronbach's alpha reliability co-efficient of analysis of the data obtained in this study was equal to 0.85.

Data analysis

After applying, the quantitative data collected by data collection tools were analyzed with SPSS v.22. Descriptive statistical analysis were performed on the collected data for each variable for both experimental and control groups. Mean ($\bar{X}$), standard deviation (SD), skewness, and kurtosis values of the collected data from both groups were measured. Before starting the application, means of Chemistry Achievement Test, Chemistry Attitude Scale, Pupils' Attitudes Towards Technology (PATT) test results belonging to both of the groups were analyzed with the independent sample t-test, whether there was a significant difference between goups scores. Parametric tests were used for analyzing post-tests. An Analysis of covariance (ANCOVA) was performed to compare groups' Chemistry Achievement Test, Chemistry Attitude Scale scores, in which pre-test was used as the covariate. It was assumed that the pupils answered questionnaires independently. A multivariate analysis of covariance (MANCOVA) was performed to compare pupils' Attitudes Towards Technology (ATT) post tests scores.

Results

Before starting the application, independent sample t-test used to compare both groups pretest scores are indicated in Table 2.

Table 2. Pre-CAT, Pre-CAS and Pre-PATT T-Test Results

Tests	Group	N	x̄	sd	Df	t	p
Pre-CAT	CG	114	1,3509	1,11294	224	3,136	,002*
	EG	112	,9464	,80359			
Pre-CAS	CG	114	54,2719	13,97487	224	2,298	,023*
	EG	112	49,7054	15,86068			
Pre-PATT	CG	114	28,3246	7,24355	224	1,528	,128
	EG	112	26,7589	8,14203			

Acording to results of analyses; it is seen that there was a significant differance between control and experiment gorups pupils pre-CAT (t(224)=3,127, p<0,05), pre-CAS (t(224)=2,298, p<0,05) score means. But there was not a significant differance between both control and experiment gorups pupils scores mean of pre-PATT (t(224)=1,528, p>0.05) score. Adjusted means of the control and experiment group pupils' academic acheivement, attitude toward chemistry and technology tests after experimental proccess scores are indicated in Table 3.

Table 3. Means Scores

Variable	Groups	N	Pre-CAT		Post-CAT		Adjusted mean	
			x̄	Df	x̄	Df	x̄	SE
CAT	CG	114	1,35	1,12	6,01	,99	6,06	,09
	EG	112	,94	,80	8,22	,92	8,22	,09
CAS	CG	114	54,27	13,97	54,08	17,35	54,19	1,59
	EG	112	49,71	15,86	61,71	16,37	61,59	1,61
PATT	CG	114	28,32	7,24	29,53	7,85	29,41	,81
	EG	112	26,75	8,14	29,15	9,29	29,27	,82

As indicated in Table 3, adjusted academic achievment post-test score mean for CG is 6,06, for EG is 8,22; adjusted attitude toward chemistry post-test score mean for CG is 54,19 and for EG is 61,59 and adjusted attitude toward technology post-test score mean for CG is 29,41 and for EG is 29,27.

ANCOVA analysis is used whether there is a significant difference between both groups' Acedemic achievment test and attitude toward cemistry scales' post-test adjusted scores means indicated in Table 4.

Table 4. ANCOVA Post-test Analysis Results

Variable	Source	Sum of Squares	Df	Mean Square	F	p	η2
CAT	Post-CAT	,04	1	,046	,050	,824	,000
	Group	251,58	1	251,58	272,42	,000	,550
	Error	205,94	223	,92			
	Total	11968,00	226				
CAS	Post-CAS	120,47	1	120,47	,422	,517	
	Group	3024,29	1	3024,29	10,59	,001	
	Error	63639,08	223	,92			
	Total	823602,00	225				

In Table 4, it is seen that there is a statistical significant difference between both control groups and experimental groups' chemistry achievment post-test adjusted scores means according to pre-test scores ($F(1\text{-}223)=272,42$, $p<0,05$). According to these results, it showed that pupils' chemistry achievment changed significantly depending on the experimental method. The application performed on the experimental groups is observed to have a large impact on success ($\eta 2=,550$). This result indicate that 55% of the variance in the dependent variable caused by the applied method. There is a statistical significant difference between both control groups and experimental groups' attitude toward chemistry post-test adjusted scores means according to pre-test scores ($F(1\text{-}223) = 10,59$, $p < 0,05$). Effect size of chemistry attitude scale (eta square) was $\eta 2=0,045$. This result indicate that 4,55% of the variance in the dependent variable caused by the applied method.

According to this; before experimental applications it was stated that there was a significant difference calculated in favor of CG between the pupils' mean scores obtained from CAT. Depending this divergence, after experimenatal application, there is a significant difference calculated in favor of EG between pupils post-test mean scores adjusted acording to pre-test obtained from CAT.

Before experimental applications it was stated that there was a significant difference calculated in favor of CG between the pupils' mean scores obtained from CAS. Depending this divergence, there was a significant difference calculated in favor of EG between pupils CAS post-test mean scores adjusted acording to pre-test obtained from CAS.

MANCOVA is used in order to determine, effects on pupils' attitudes toward technology during instruciton by using en-book, whether there is a significant difference between the pupils' post-test scores of attitude toward technology test using pre-test scores used as covariate(Table 5). According to Table 5, it has been concluded that there was no significant difference between attitude toward technology post-test score average adjusted acording to pre-test of the groups (Wilk's λ= ,997, F(4-217)=,190, p>0,05).

Table 5. MANCOVA Results of Post- PATT Components Scores

Effect	Wilk's λ	F	Hypothesis Df	Error Df	p
Intercept	,59	36,82	4	217	,000
Post -TT	,97	1,24	4	217	,943
Post -NT	,97	1,51	4	217	,292
Post -ICT	,96	1,86	4	217	,198
Post-TFA	,98	,60	4	217	,658
Group	,99	,19	4	217	,943

Instructional Materials Motivation Survey (IMMS) used in order to determine how teaching material affects the motivation of pupils in the course. Therefore, the survey was only applied to the experimental group, who educated by using material has been designed for course, as post-test after application.

The data obtained from IMMS are analyzed in 4 componenets as attention, relevance, confidence, satisfaciton. The all pupils scores about these components are indicated in Figure 3.

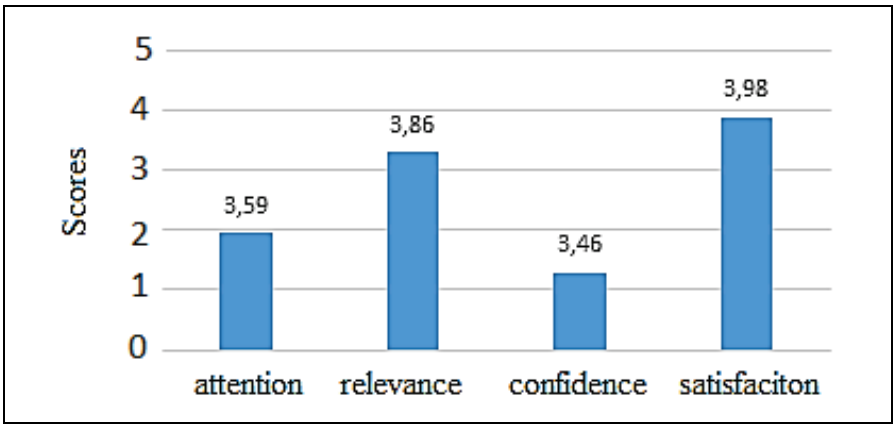


Figure 3. IMMS Results

It is indicated in Figure 3 that four components mean IMMS scores were; attention ($\bar{X}$=3,59), relevance ($\bar{X}$=3,86), confidance ($\bar{X}$=3,46), satisfaction ($\bar{X}$=3,98) and the degrees of the means were "high". When looking at the overall average of the scores ($\bar{X}$=3,72) obtained from the survey shows that a high level. According to the results; it was determined that the materials which developed for en-book was made a positive contribute to pupils' motivation.

Discussion, Conclusion and Suggestions

The effect of the instructional material on pupils' chemistry achievement, attitude towards chemistry and technology, motivation towards the instructional material were investigated in this study. According to the findings of this study, there was a statistically significant difference between the control group which was educated by conventional teaching method and experimental group which was educated by the en-book in favor of the experimental group. It can be said that the reason of this divergence is the teaching method (en-book, reached by animations, videos etc.). Maynard and Cheyne (2005) indicated that the e-textbook increase the achievement of pupils and motivate them. The feature that differentiate the en-book from e-book is multimedia enriched applications such as animation, simulation, video etc. The fact is that the most positive methaphor about the en-book in Özer and Türel (2015) study was "it appeals to multiple senses" support this. There are numerous studies indicating that the pupils who studying with the aid of multimedia instructional material could improve their achievement (Ardac & Akaygun, 2004; Talib, Matthews, & Secombe, 2005; Demirci, 2008; Marbach-Ad, Rotbain, & Stavy, 2008; Su, 2008; Para & Ayvaz Reis, 2009; Bayram, Özdemir, & Koçak, 2011; Güven & Sülün, 2012; Kunduz, 2013; Kablan, Topan, & Erkan, 2013; Ercan, 2014; Guerrero & Guerrero, 2014). It was showed in some studies that even just applying animations usage in the chemistry teaching can significantly increased pupils' achievement (Kolomuc, Özmen, Metin, & Açışlı, 2012; Tepla & Klimova, 2015). Laboratory experiments was also interactively designed with the aid of animations. It has been seen during the practice that this experiments attracted the attention of the pupils to facilitate the understanding and increase their motivation (Climent-Bellido, 2003; Tüysüz, 2010; Tatlı & Ayas, 2013; Kamtor, 2016; Duman & Avcı, 2016; Herga et al., 2016).

In this study, a statically significant differance between CAS post-test scors of control and experiment groups in fever of experiment group was found. When the courseis carried out by the en-book which was based on multimedia applications, it is showed in some studies that it affected pupils' attitude towards the course positively (Su, 2008; Kahraman, 2010; Usta, 2011; Bayram et al., 2011; Öğünç, 2012; Yunus & Ali, 2013; Ercan, 2014; Guerrero & Guerrero, 2014; Mahdi, 2014). It can be argued that this divergence is due to the en-book has been used by experiance group during the courses. To the contrary, Güven and Sülün's (2012) study are not consistent with our finding. As a reason, it has been demonstrated that the research is carried out in a short time and the pupils' first time encountering such an application.

In this study we investigated the significant differences between the attitudes towards the tecnology of sample group which is learned by the en-book and the the conntrol group which is learned by traditional method. Our findings verified that no significant differences observed between the sample groups towards technology. In the literatures it is showed that the studends who has techonological tools such as cellphone, computer, PC laptp, etc. have better academik standig than others. (Yarar & Karabacak, 2014; Şahin, Deniz, & Ekli, 2015; Ardies, De Maeyer, Gijbels, & van Keulen, 2015). As a result, it was because of tablet computers have not yet been deployed in the schools where the study was conducted and according to the the school headmaster who information was received from, the socio-economic situation of the pupils in general was low (Şahin et al., 2015). Pupils who have positive feelings on technology exhibit positive attitude towards chemistry (Kıyıcı, Kahraman, & Abali, 2012). This is the fact that the most effective user group of technology is pupils. In this context it can be said that pupils will also use technological tools such as tabletPC etc. on lessons effectively and this ensures pupils to develop positive attitudes towards related lesson. It has been observed that while the course is being executed, the pupils were more willing and successful at using and making smart board adjustments when the teacher is hesitant to use it. This is consistent with the findings.

In the scope of this study the learning motivation survey applied to the sample which is educated by the en-book. The results show that the developed en-book made an affirmative contribution on the motivation of pupils. It is determined that visually concretized expression of the abstract concepts related to chemistry lesson increased the motivation and achivement of pupils on the lessons. It can be said that the materials including moving animations, being enable to carry out experiments which they

are unable at school on virtual environment, being teaching plays at the end of the chapters, supported courses by videos and assisting pupils to comprehend enjoyably the concepts of related courses which pupils have difficulty to understand as reasons (Rosen, 2009; Soika, Reiska, & Mikser, 2010; Tüysüz, 2010; Leal & Leal, 2011; Bayrakçı & Demirbaş, 2011; Barak, Ashkar, & Dori, 2011; Akıncı et al., 2012).

As a consequence of the research it is determined that developed en-book increased the achivement of pupils towards the lessons and rises the attitudes towards chemistry and motivate the pupils but there is no change occured towards technology. By using multimedia tools particularly interactive ones (such as animations, simulations etc.) due to stand pupils more active durring course, presented opportunity both to observe the concrete concepts which they were forced to understand and to eliminate the concept complexities. At the same time, it was determined that the pupils' interest in the lesson increased and they showed a positive attitude accordingly.

The en-book enables pupils to repeat the courses by watching animation videos on their own computer at home alone. They will be able to reach the knowledge whenever and wherever they want with the aid of tablet PC. So this type of contents should be developed and teachers have to encourage to use these contenets at schools. Because the teachers are still afraid of using the technology (Hakkari, Tüysüz, & Atalar, 2016). In the process of en-book development; the features of the target pupils should not be overlooked in terms of the design, guidelines, usage and accessibility of the en-book (Sarıtepeci & Yıldız, 2013). During the development, so as not to encounter such troubles in the work done has been repeatedly tested with both the teacher of the course and two instructors in the field of chemistry.

However, development of interactive books in the OEF Project studies should be by the Fatih Project by the Ministry of Education. The study is an example for the system proposed before as a collaborative work of a computer expert, two chemistry faculty members and a chemistry teacher. In particular, the content problems of FATIH Project, the inadequacies and fears of teachers in using technological tools are seen as lacks that should be remedied sooner because the teachers' attitudes towards technology are affected by the pupils. In order to teachers use the technological tools provided by the study effectively, the number of experts should be increased to provide professional technological, pedagogical support. Internet infrastructure works (speed, bandwidht ect.) should be completed in a usable way for ICT usage in schools. Because, there are problems originating from low speed during the course about accessing and loading the material such as video etc. via the internet. Since designing z-books for all levels of instruction involves all multimedia tools, it is thought that such negativities will be abandoned. It is recommended to establish a secure system to prevent pupils using their tablet PC for other purposes except for the subjects during the course.

References

Akıncı, A., Kurtoğlu, M., & Seferoğlu, S. S. (2012). *Bir teknoloji politikası olarak FATİH projesinin başarılı olması için yapılması gerekenler: Bir durum analizi çalışması*. Paper presented at Akademik Bilişim 2012, Uşak University, Uşak.

Aktaş, S. (2014). *Kimyasal türler arası etkileşimler ünitesine yönelik başarı testi geliştirilmesi* (Unpublished master's course homework).

Albayrak, M., Kültür, C., Erden, O., & Tonguç, G. (2003). İnternet destekli eğitimde içerik geliştirme ve sürecin önemi. In *III. Uluslararası Eğitim Teknolojileri Fuarı* (pp. 486-495).

Alwin, D. F., & Krosnick, J. A. (1991). The reliability of survey attitude measurement: The influence of question and respondent attributes. *Sociological Methods and Research*, *20*(1), 139-181.

Ardac, D., & Akaygun, S. (2004). Effectiveness of multimedia-based instruction that emphasizes molecular representations on students' understanding of chemical change. *Journal of Research in Science Teaching*, *41*(4), 317-337.

Ardies, J., De Maeyer, S., Gijbels, D., & van Keulen, H. (2015). Students attitudes towards technology. *International Journal of Technology and Design Education*, *25*(1), 43-65.

Arıcı, N., & Dalkılıç, E. (2006). Animasyonların bilgisayar destekli öğretime katkısı: Bir uygulama örneği. *Kastamonu Eğitim Dergisi*, *14*(2), 421-430.

Balaban Salı, J. (2003). Çevrimiçi eğitimde güdüleyici öğrenme sistemlerinin tasarımı. *Kurgu Dergisi*, *20*, 267-280.

Bame, E. A., Dugger, W. E., de Vries, M., & McBee, J. (1993). Pupils' attitudes towards technology-PATT-USA. *The Journal of Technology Studies*, *19*(1), 40-48.

Barak, M., Ashkar, T., & Dori, Y. J. (2011). Learning science via animated movies: Its effect on students' thinking and motivation. *Computers & Education Archive*, *56*(3), 839-846.

Bayrakçı M., & Demirbaş M. (2011). Chemistry teaching student motivation: The case of Turkey. *Chemistry is in All Around Network*.

Bayram, K., Özdemir, E., & Koçak, N. (2011). Kimya eğitiminde animasyon kullanımı ve önemi. *Selçuk Üniversitesi Ahmet Keleşoğlu Eğitim Fakültesi Dergisi*, *32*, 371-390.

Bozkurt, A., & Bozkaya, M. (2013). Etkileşimli e-kitap: Dünü, bugünü ve yarını. In *Akademik Bilişim 2013* (pp. 375-381). Antalya: Akdeniz University. Retrieved from http://www.academia.edu/2536903/Etkilesimli_E-Kitap_Dunu_Bugunu_ve_Yarini

Bozkurt, A., & Bozkaya, M. (2015). Evaluation criteria for ınteractive e-books for open and distance learning. *The International Review of Research in Open and Distributed Learning*, *16*(5).

Bozkurt, Ö. A. (2015). Kitlesel açık çevrimiçi dersler (Massive Open Online Courses-MOOCs) ve sayısal bilgi çağında yaşamboyu öğrenme fırsatı. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi*, *1*(1).

Cheung, D. (2009). Developing a scale to measure students‟ attitudes toward chemistry lessons. *International Journal of Science Education*, *31*(16), 2185-2203.

Climent-Bellido, M. S. (2003). Learning in chemistry with virtual laboratories. *Journal of Chemical Education*, *80*(3), 346-352.

Çınar, D., & Akgün, Ö. E. (2015). Ders kitabı tasarımında artırılmış gerçeklik kullanımı: Bir ingilizce ders kitabı bölümü örneği. In *VII. Ulusal Lisansüstü Eğitim Sempozyumu* (pp. 98-103).

Çifçili, V., Sertelin Mercan, Ç., Emir, S., & Kahveci, N. G. (2012). Fatih Projesi pilot uygulama değerlendirmesi (Unpublished Report, pp. 86-112).

Daşdemir, İ., & Doymuş, K. (2012). Fen ve teknoloji dersinde animasyon kullanımının öğrencilerin akademik başarılarına, öğrenilen bilgilerin kalıcılığına ve bilimsel süreç becerilerine etkisi. *Pegem Eğitim ve Öğretim Dergisi*, *2*(3), 33-42.

Demirci, A. (2008). *Bilgisayar destekli sabit ve hareketli görsel materyallerin kimya öğretiminde öğrenci başarısına etkisi* (Unpublished master's thesis). Selçuk University, Graduate School of Natural and Applied Sciences, Konya.

Demirli, C. & Dikilci, A. (2003). Öğretimde web tabanlı uygulamaların öğrenci başarısına etkisi. In *III. Uluslararası Eğitim Teknolojileri Fuarı* (pp. 758-770).

Duman, M. Ş., & Avcı, G. (2016). Sanal laboratuvar uygulamalarının öğrenci başarısına ve öğrenilenlerin kalıcılığına etkisi. *Journal of Education Faculty*, *18*(1), 13-33.

Ebied, M. M. A., & Rahman, S. A. A. (2015). The effect of ınteractive e-book on students' achievement at najran university in computer in education course. *Journal of Education and Practice*, *6*(19), 71-82.

Embong, A. M., Noor, A. M., Ali, R. M. M., Bakar, Z. A. ve Amin, A. R. M. (2012). Teachers' perceptions on the use of e-books as textbooks in the classroom. *World Academy of Science, Engineering and Technology International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, *6*(10), 2638-2644.

Emrahoğlu, N., & Bülbül, O. (2010). 9. Sınıf fizik dersi optik ünitesinin bilgisayar destekli öğretiminde kullanılan animasyonların ve simülasyonların akademik başarıya ve akılda kalıcılığa etkisinin incelenmesi. *Ç.Ü. Sosyal Bilimler Enstitüsü Dergisi*, 19(3), 409-422.

Ercan, O. (2014). The effects of multimedia learning material on students' academic achievement and attitudes towards science courses. *Journal of Baltic Science Education*, *13*(5), 608-621.

Erorta Ö., & Kayabaş, İ. (2015, 4-6 February). *Anadolu üniversitesi etkileşimli e-kitap projesi*. Paper presented at Akademik Bilişim'15, Anadolu University, Eskişehir. Retrieved from http://docplayer.biz.tr/7876153-Anadolu-universitesi-etkilesimli-e-kitap-projesi.html

Guerrero, M., & Guerrero, G. (2014). The effect of a multimedia application in the oxidation-reduction reaction learning process. In *TEEM'14 Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality* (pp. 343-347).

Güven, G., & Sülün, Y. (2012). Bilgisayar destekli öğretimin 8.sınıf fen ve teknoloji dersindeki akademik başarıya ve öğrencilerin derse karşı tutumlarına etkisi. *Türk Fen Eğitimi Dergisi*, *9*(1), 68-79.

Güzeller, C., & Korkmaz, Ö. (2007). Bilgisayar destekli öğretimde bir ders yazılımı değerlendirmesi. *Kastamonu Eğitim Dergisi*, *15*(1), 155-168.

Hakkari, F., Tüysüz, C., & Atalar, T. (2016). Öğretmenlerin bilgisayar yeterlikleri ve öğretimde teknoloji kullanımına ilişkin algılarının çeşitli değişkenler bakımından incelenmesi. *Bayburt Eğitim Fakültesi Dergisi*, *10*(2), 460-481.

Herga, N. R., Čagran, B., & Dinevski, D. (2016). Virtual laboratory in the role of dynamic visualisation for better understanding of chemistry in primary school. *Eurasia Journal of Mathematics, Science & Technology Education*, *12*(3), 593-608.

Hwang, G. J., Sung, H. Y., & Chang, H. (2016). Effects of concept mapping-based interactive e-books on junior high school students' learning performance in law courses. *Interactive Learning Environments*, 1-12.

Itzkovitch, A. (2012). Interactive ebook apps: the reinvention of reading and interactivit. *Uxmagazine*, 816. Retrieved November 10, 2014, from http://uxmag.com/articles/interactive-ebook-apps-the-reinvention-of-reading-and-interactivity.

Kablan, Z., Topan, B., & Erkan, B. (2013). Sınıf içi öğretimde materyal kullanımının etkililik düzeyi: Bir meta-analiz çalışması. *Kuram ve Uygulamada Eğitim Bilimleri (Educational Sciences: Theory & Practice) 13*(3), 1629-1644.

Kahraman, S. (2010). *Atomun yapısı ve orbitaller konusunda geliştirilen üç boyutlu bilgisayar destekli öğretim materyallerinin öğretmen adaylarının başarısı ve tutumlarına etkisi* (Unpublished doctoral dissertation). Atatürk University, Graduate School of Natural and Applied Sciences, Erzurum.

Kamtor, E. E. (2016). The impact of virtual laboratories on academic achievement and learning motivation in the students of sudanese secondary school. *International Journal of English Language, Literature and Humanities*, *4*(9), 464-483

Karalar, H., & Sarı, Y. (2007). Bilgi teknolojileri eğitiminde BDÖ yazılımı kullanma ve uygulama sonuçlarına yönelik bir çalışma. In *Akademik Bilişim 2007* (p. 31). Kütahya: Dumlupınar University.

Karasar, N. (2012). *Bilimsel araştırma yöntemi-kavramlar-ilkeler-teknikler* (23th ed.). Ankara: Nobel Akademi Publishing.

Kayaduman, H., Sırakaya, M., & Seferoğlu, S. S. (2011). Eğitimde FATİH projesinin öğretmenlerin yeterlik durumları açısından incelenmesi. In *Akademik Bilişim 2011* (pp. 123-129).

Keller, J. (2000). How to integrate learner motivation planning into lesson planning: The ARCS model approach. In *VII Semanario* (pp. 1-17).

Keller, J. M. (1987a). Strategies for stimulating the motivation to learn. *Performance and Instruction*, *26*(8), 1-7.

Keller, J. M. (1987b). The systematic process of motivational design. *Performance and Instruction*, *26*(9-10), 1-8.

Keller, J. M. (1987c). *IMMS: Instructional materials motivation survey*. Tallahassee, Florida: Florida State University.

Kıyıcı, G., Kahraman, N., & Abali, Y. (2012). Kimyager adaylarının teknoloji tutumlarının kimya tutumlarına etkisinin araştırılması. *Eğitim Teknolojileri Araştırmaları Dergisi*, *3*(1).

Kolomuc, A., Özmen, H., Metin, M., & Açışlı, S. (2012). The effect of animation enhanced worksheets prepared based on 5E model for the grade 9 students on alternative conceptions of physical and chemical changes. *Procedia-Social and Behavioral Sciences*, *46*, 1761-1765.

Kunduz, N. (2013). *Animasyonlarla Öğretimin ve eğitsel oyunların çöktürme titrimetrisi konusunda akademik başarı üzerine etkisi* (Unpublished master's thesis). Hacettepe University, Graduate School of Natural and Applied Sciences, Ankara.

Kutu, H., & Sözbilir, M. (2011). Öğretim materyalleri motivasyon anketinin Türkçeye uyarlanması: Güvenirlik ve geçerlik çalışması. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi (EFMED)*, *5*(1), 292-312.

Leal, S. C., & Leal, J. P. (2011). *Production of educational material for the teaching of chemistry*. Paper presented at MPTL16 - HSCI 2011 Conference, Ljubljana.

Mahdi, J. G. (2014). Student attitudes towards chemistry: an examination of choices and preferences. *American Journal of Educational Research*, *2*(6), 351-356.

Marbach-Ad, G., Rotbain, Y., & Stavy, R. (2008). Using computer animation and ılllustration activities to improve high school students' achievement in molecular genetics. *Journal of Research in Science Teaching*, *45*(3), 273-292.

Maynard, S., & Cheyne, E. (2005). Can electronic textbooks help children to learn?. *The Electronic Library*, *23*(1), 103 - 115

Ministry of National Education. (2011). Z-Kitap ile ilgili ortak çalışmalar. Retrieved from http://fatihprojesi.meb.gov.tr/tr/duyuruincele.php?id=9

Mitropoulou, V. (2012). Interactive books for primary and secondary education for the course of religion in Greece. In *IADIS International Conference on Cognition and Exploratory Learning in Digital Age* (pp. 269-273). Retrieved from http://files.eric.ed.gov/fulltext/ED542826.pdf

Nguyen, G. N. (2015). Designing and using interactive e-books in Vietnam. *International Journal of Learning, Teaching and Educational Research*, *11*(1).

Odabaş, H. (2003). İnternet tabanlı uzaktan eğitim ve bilgi ve belge yönetimi bölümleri. *Türk Kütüphaneciliği*, *17*(1), 22-36.

Öğünç, A. (2012). *Kimya dersi "reaksiyon hızları ve kimyasal denge" ünitesiyle ilgili yapılandırmacı yaklaşıma dayalı bir aktif öğrenme materyalinin geliştirilmesi, uygulanması ve değerlendirilmesi* (Unpublished doctoral dissertation). Dokuz Eylül University, Institute of Educational Sciences, İzmir.

Özer, S., & Türel, Y. (2015). Bilişim teknolojileri öğretmen adaylarının e-kitap ve etkileşimli e-kitap kavramına ilişkin metaforik algıları. *Turkish Online Journal of Qualitative Inquiry* (*TOJQI*), *6*(2).

Paivio, A. (1986). *Mental representations: A dual coding approach*. New York: Oxford University Press.

Pamuk, S., Çakır, R., Ergun, M., Yılmaz, H. B., & Ayas, C. (2013). Öğretmen ve öğrenci bakış açısıyla tablet PC ve etkileşimli tahta kullanımı: FATİH Projesi değerlendirmesi. *Kuram ve Uygulamada Eğitim Bilimleri*, *13*(3), 1799-1822.

Para, D., & Ayvaz Reis, Z. (2009). Eğitimde bilişim teknolojileri kullanılması: Kimyada su döngüsü. In *Akademik Bilişim Konferansı Bildirileri* (pp. 11-13).

Pekdağ, B. (2010). Kimya öğreniminde alternatif yollar: Animasyon, simülasyon, video ve multimedya ile öğrenme. *Türk Fen Eğitimi Dergisi*, *7*(2), 79-110.

Rosen, Y. (2009). The effects of an animation-based on-line learning environment on transfer of knowledge and on motivation for science and technology learning. *Journal of Educational Computing Research*, *40*(4), 451-467.

Rusanganwa, J. A. (2015). Developing a multimedia instrument for technical vocabulary learning: A case of EFL undergraduate physics education. *Computer Assisted Language Learning*, *28*(2), 97-111.

Sarıtepeci, M., & Yıldız, H. (2013). *Milli eğitim bakanlığı tarafından hazırlanan örnek z-kitabın kullanılabilirlik analizi. TBD 30. Ulusal Bilişim Kurultayı Bildiriler Kitabı*. Ankara.

Shamir, A., & Shlafer, I. (2011). E-books effectiveness in promoting phonological awareness and concept about print: A comparison between children at risk for learning disabilities and typically developing kindergarteners. *Computers & Education*, *57*(3), 1989-1997.

Soika, K., Reiska, P., & Mikser, R. (2010). *The importance of animation as a visual method in learning chemistry*. Estonia: Tallinn University.

Soydan, E. (2012). E-kitap teknolojisi ve basılı kitabın geleceği. *Batman Üniversitesi Yaşam Bilimleri Dergisi*, *1*(1), 389-399.

Strommen, E. F. (1992). Formative Studies in the Development of a New Computer Pointing Device for Young Children. *Educational Technology*, *32*(4), 43-51.

Su, K. (2008). The effects of a chemistry course with integrated information communication technologies on university students' learning and attitudes. *International Journal of Science and Mathematics Education*, *6*(2), 225-249.

Şahin, N., Deniz, S., & Ekli, E. (2015). Middle school students' attitudes towards technology in relation to demographic and affective domain. *Muğla Sıtkı Koçman Üniversitesi Eğitim Fakültesi Dergisi*, *1*(3).

Şen, Ş., & Yılmaz, A. (2013). Kimyasal bağlarla ilgili fenomenografik bir çalışma. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi (EFMED)*, *7*(2), 144-177.

Şenocak, E. (2011). Kimya dersi tutum ölçeğinin Türkçeye uyarlanması çalışması. *Journal of Turkish Science Education*, *8*(2).

Talib, O., Matthews, R., & Secombe, M. (2005). Constructivist animations for conceptual change: An effective ınstructional strategy in understanding complex, abstract and dynamic science concepts. *Malaysian Online Journal of Instructional Technology*, *2*(3), 78-87.

Tania, L., & Fadiawati, N. (2015). Development of interactive e-book based on chemical representation refer to curriculum 2013. *Jurnal Pendidikan IPA Indonesia (Indonesian Journal of Science Education)*, *4*(2).

Tatlı, Z., & Ayas, A. (2013). Effect of a virtual chemistry laboratory on students' achivement. *Educational Technology & Society*, *16*(1), 159-170.

Tepla, M., & Klimova, H. (2015). Using adobe flash animations of electron transport chain to teach and learn biochemistry. *Biochemistry and Molecular Biology Education*, *43*(4), 294-299.

Tüysüz, C. (2010). The effect of the virtual laboratory on students' achievement and attitude in chemistry. *International Online Journal of Educational Sciences*, *2*(1), 37-53.

Usta, N. (2011). *Yapılandırmacı öğrenme kuramı çerçevesinde bilgisayar destekli öğretim materyali geliştirilmesi, uygulanması ve etkililiğinin değerlendirilmesi: Çekirdek kimyası (radyoaktivite)* (Unpublished doctoral dissertation). Karadeniz Teknik University, Institute of Educational Sciences, Trabzon.

Üzel, D., & Özdemir, E. (2012). The Effects of Problem-Based E-Learning on Prospective Teachers' Achievements and Attitudes towards Learning Mathematics. *Procedia Social and Behavioral Sciences*, *55*, 1154-1158.

Varol, F., Özer, S., & Türel, Y. K. (2014). ARCS motivasyon modeline yönelik tasarlanan z-kitaplara ilişkin görüşler. *Journal of Instructional Technologies & Teacher Education*, *3*(3), 1-8.

Yarar, İ., & Karabacak, K. (2014). 8th grade students' attitude towards technology. *Procedia-Social and Behavioral Sciences*, *174*, 2051-2060.

Yayon, M., Mamlok-Naaman, R., & Fortus, D. (2012). Characterizing and representing student's conceptual knowledge of chemical bonding. *Chemistry Education Research and Practice*, *13*, 248-267.

Yılmaz, K., & Horzum, B. (2005). Küreselleşme, bilgi teknolojileri ve üniversite. *Eğitim Fakültesi Dergisi*, *6*(10), 103-121.

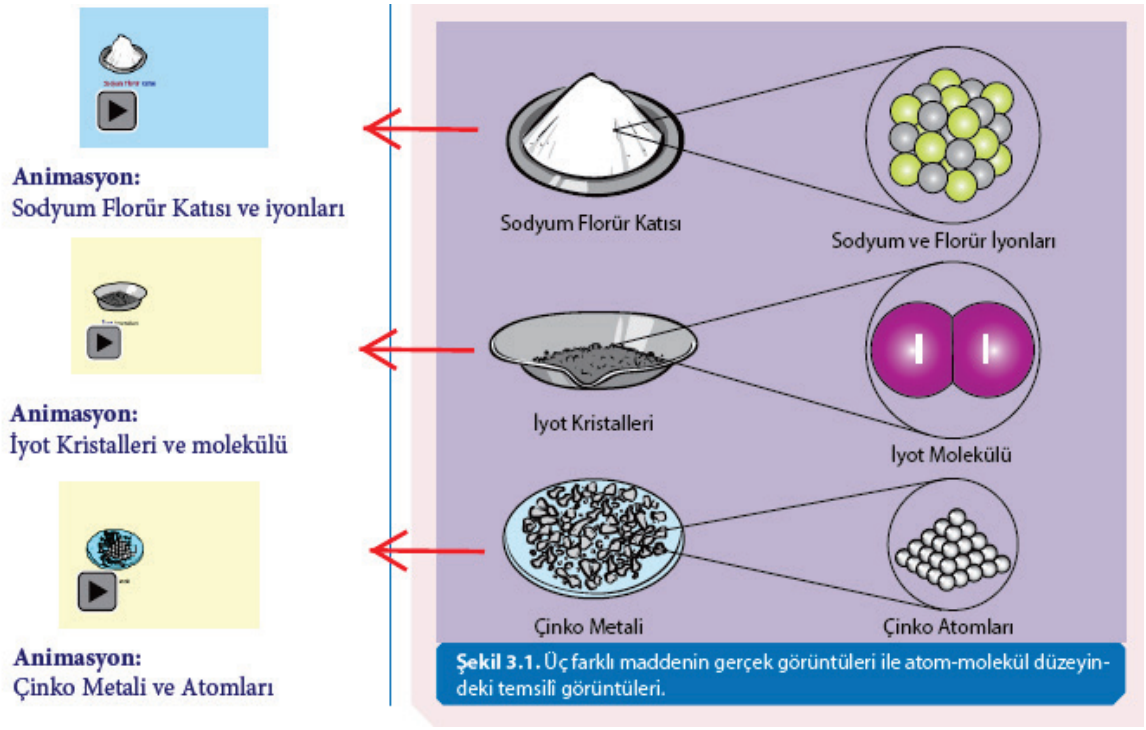
Yunus, F. W., & Ali, Z. M. (2013). Attitude towards learning chemistry among secondary school students in Malaysia. *Journal of Asian Behavioural Studies*, *3*(11), 1-11.

Yurdugül, H., & Aşkar, P. (2008). Öğrencilerin teknolojiye yönelik tutum ölçeği faktör yapılarının incelenmesi: Türkiye örneği. *Elementary Education Online*, *7*(2), 288-309.

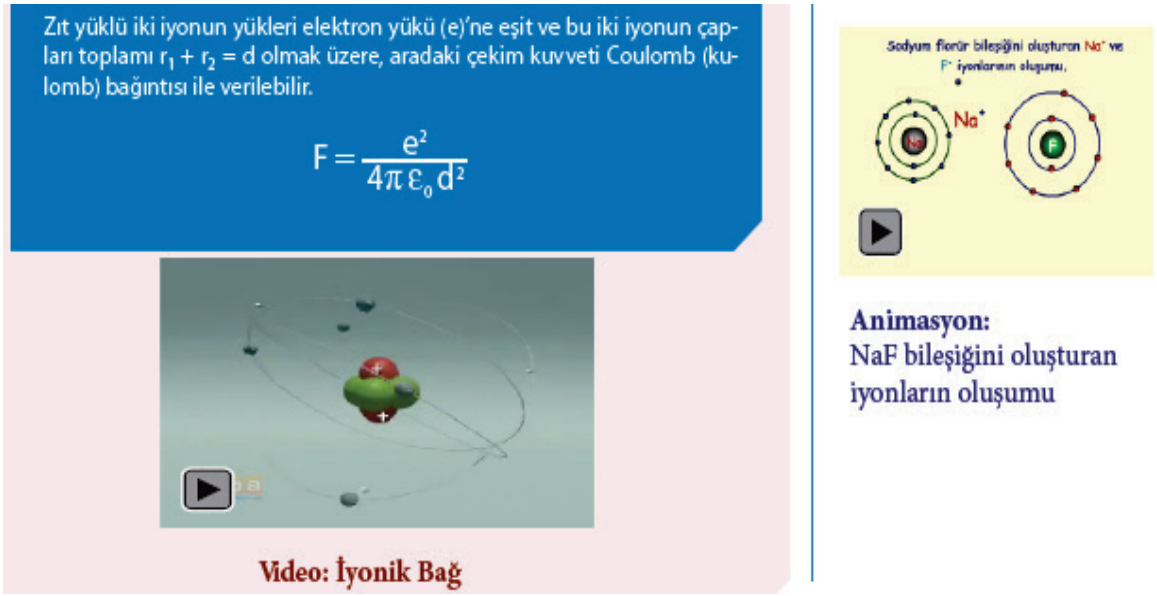
Zahra, S. B. (2016). Effect of visual 3d animation in education. *European Journal of Computer Science and Information Technology*, *4*(1), 1-9.

Appendix 1. Animation, Video and Page Examples Used in the En-Book Basis On Topic-By-Topic

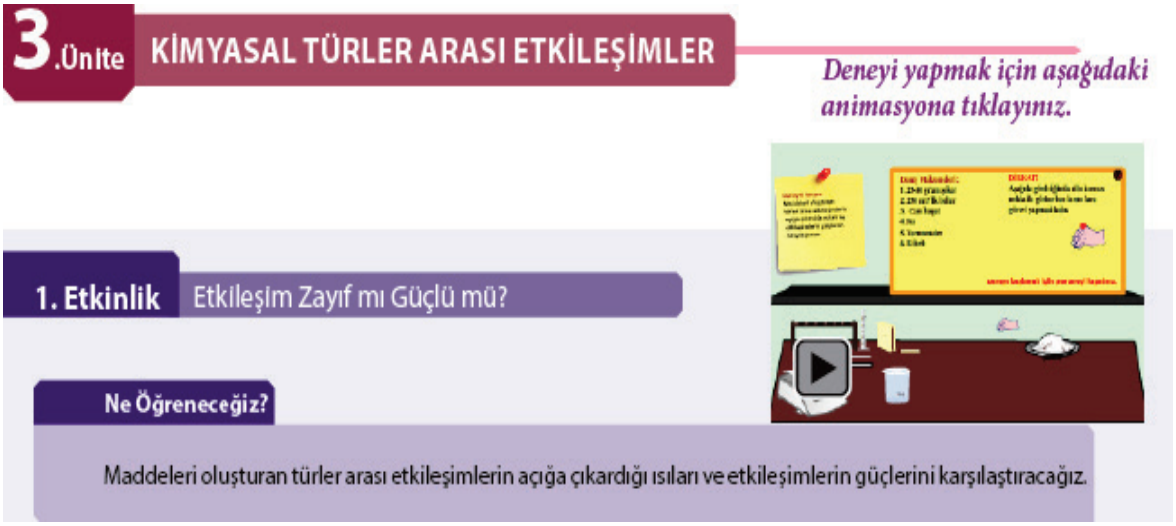
Unit 3: Interactions Between Chemical Species
Chapter 1: What is the chemical species?



Bonds Between Ions

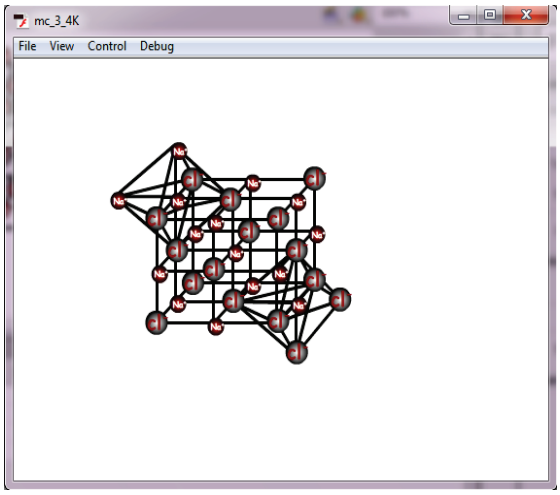


Chapter 2: Classification of Interactions Between Chemical Species

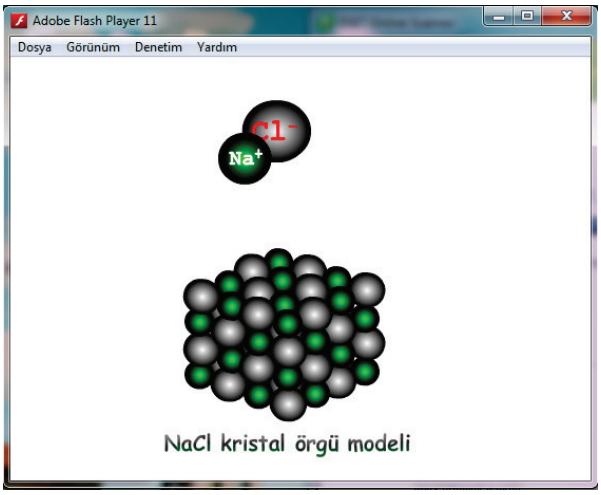


Chapter 3: Strong Interactions

Immediate Vicinity of Na+ and Cl- Ions in NaCl Lattice



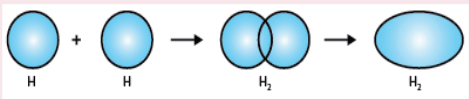
NaCl Lattice



3. 3. Nonpolar Covalent Bonds

Apolar Kovalent Bağ

Birer elektron içeren hidrojen atomlarının elektron dizilimlerini en yakın soy gaz olan helyuma benzetmek için bir tane fazladan elektrona ihtiyaçları vardır. İki hidrojen atomu bir araya gelince her ikisinin birer elektronu eşleşir ve iki atom tarafından ortak ve eşit ölçüde kullanılır. Böylece bir "apolar kovalent bağ" oluşur (**Şekil 3.6**). İki atomlu hidrojen molekülü (H_2) serbest hâldeki iki hidrojen atomuna göre oda şartlarında daha kararlıdır. Ancak, 2000 °C'un üzerinde bağımsız H atomları bulunabilir.



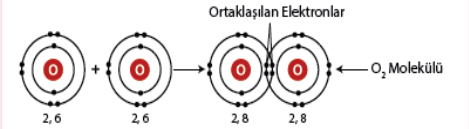
Şekil 3.6. Hidrojen molekülünde apolar kovalent bağ.

İki hidrojen atomundan H_2 molekülünün oluşumuna ilişkin Lewis gösterimi şu şekildedir:

$$H\cdot + \cdot H \rightarrow H:H \leftrightarrow H-H$$

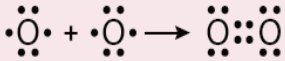
Apolar Kovalent Bağ Örnekleri

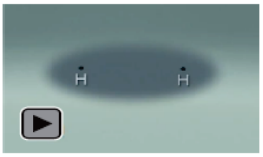
Oksijen molekülü (O_2):
Her iki O atomunun son katmanında altışar elektron vardır. Bu atomlar oktete ulaşmak için ikişer elektron ortaklaşmalıdır (**Şekil 3.7**).



Şekil 3.7. Oksijen atomlarında ve O_2 molekülünde elektron dizilimleri.

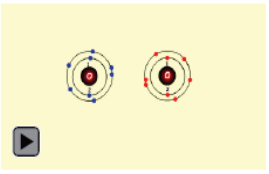
O_2 molekülünün atomlarından oluşumuna ilişkin Lewis gösterimi aşağıdaki gibidir:





Video:
Apolar Molekül Nedir?

Animasyon:
H_2 molekülünde apolar kovalent bağ



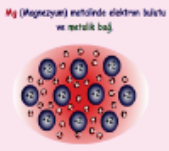
Animasyon:
O atomlarında ve O_2 molekülünde elektron dizilimleri.

3.5. Metallic Bond

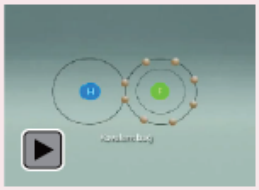
Metalik Bağ

Metal atomlarının en son katmanlarındaki elektronlar ile atomun çekirdeği arasındaki çekim kuvvetleri oldukça zayıftır. Bu elektronlar metal örgülerinde serbest hâlde dolaşabilir. Elektron kaybetmiş atomların pozitif iyonları, serbest dolaşan elektronların oluşturduğu elektron bulutunu; elektron bulutu da metal katyonlarını çeker ve böylece örgü içinde tutar. Dış katmanında iki elektron bulunan Ca gibi bir metalin örgüsüne ilişkin elektron bulutu **Şekil 3.18**'deki gibidir.

Metalik bağ, elektron bulutu ile pozitif iyonlar arasındaki elektriksel çekim kuvvetidir. Bu bağların enerjisi, iyonik ve kovalent bağlarla aynı mertebedendir. Elektron bulutu içindeki katyonlar, metalik bağlar kopmadan kolayca hareket edebildikleri için metaller genelde yumuşaktır ve kolaylıkla işlenebilir (tel/levha hâline gelebilir, dövülebilir). Sert olan ve yüksek sıcaklıkta eriyen Cr, W gibi metallerde atomlar birbirine hem metalik hem de kovalent bağlarla bağlıdır. Bağlar çeşitlenip sağlamlaştıkça metal sertleşir, erime noktası yükselir.



Animasyon: Mg metalinde elektron bulutu.

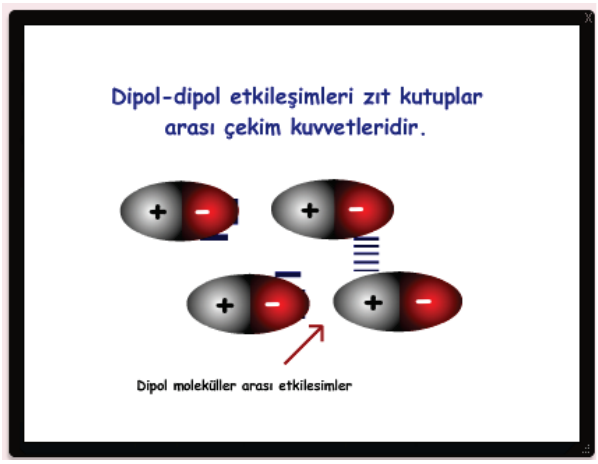


Video: Metalik Bağ

Chapter 4: Weak Interactions

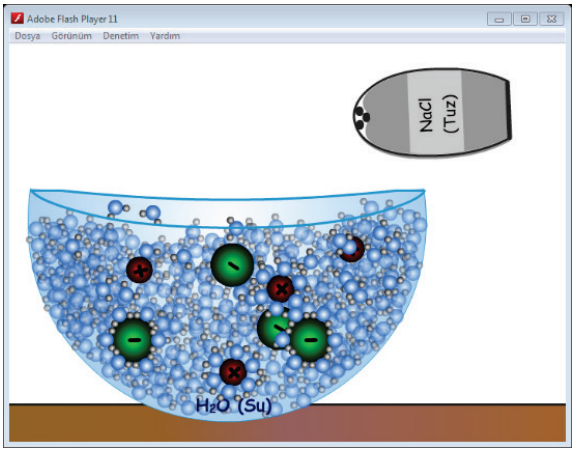
4.1. Van der Waals Interactions

Dipole-Dipole Interactions



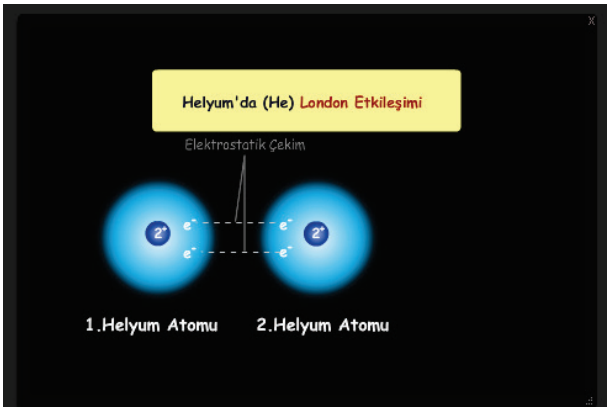
Dipole-dipole interactions are opposite pole-to-pole forces.

Ion-Dipole Interactions



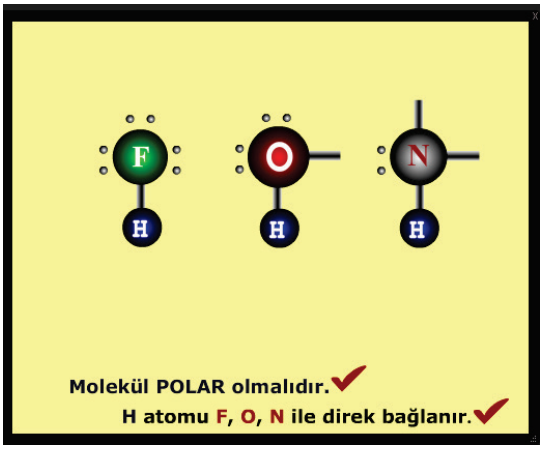
Ion-dipole Interactions of NaCl (salt) in Water Solutions (H2O).

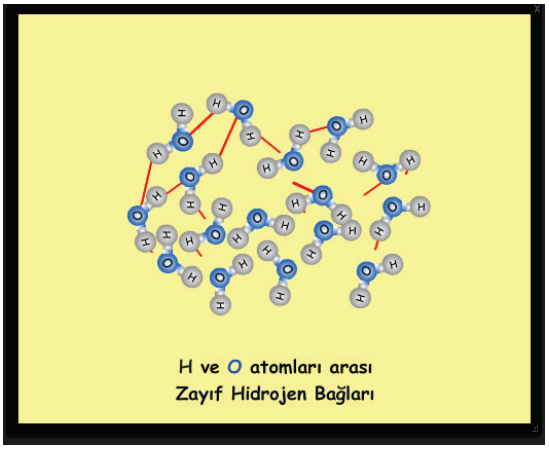
London Dispersion Forces



Helium London dispersion interaction

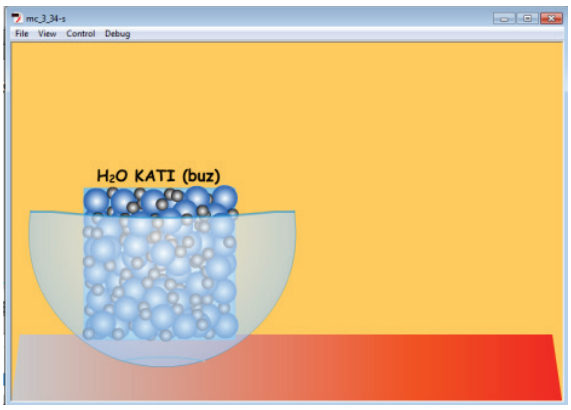
4.2. Hydrogen Bonds



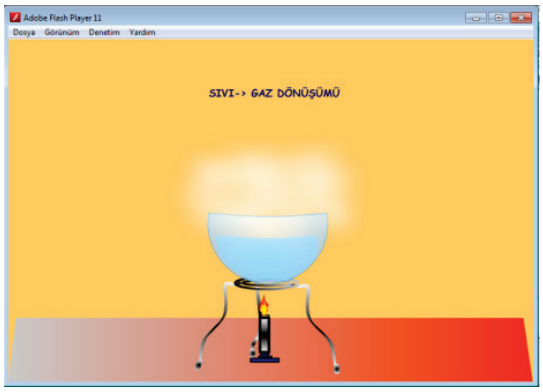


Chapter 5: Physical and Chemical Changes

5.1. Physical Change

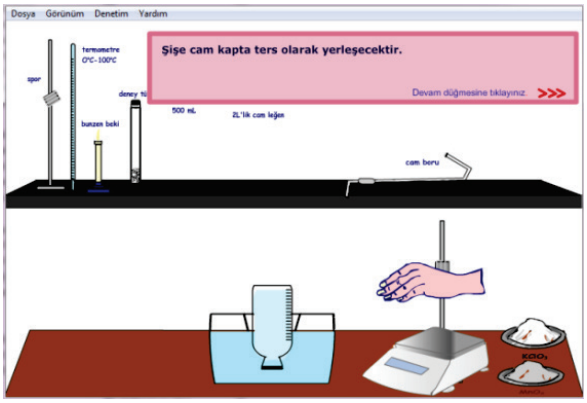


Suyun (H2O) katı hali.



Suyun sıvı halden gaz haline dönüşümü.

5.2. Chemical Change



Sample of Lab Animasion1

Sample of Lab Animasion2