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The Use of Web 2.0 Applications in Chemistry Teaching: Acids, Bases and Salts Unit[1]

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By engaging the focus of today's students, who are immersed in technology from birth, the employment of Web 2.0 tools in the educational process enriches learning environments. Because of this, the purpose of this study is to ascertain the impact of course materials created using Web 2.0 applications on the academic achievement and attitudes of 10th-grade chemistry students in the unit on "Acids, Bases, and Salts." One of the quantitative research techniques used in this study is a quasi-experimental design with a pre-and post-test control group. For this reason, students in the experimental group who used course materials developed by Web 2.0 applications and the control group who used the traditional teaching methods had their academic achievement scores and attitudes in the chemistry course compared. 48 students in the 10th grade of a public high school in a district of one of Turkey's most populous provinces participated in the study. The application procedure lasted 9 weeks. The academic achievement test post-test scores of the experimental and control groups showed a statistically significant difference in favor of the experimental group, according to the analysis's findings, whereas there was no statistically significant difference between the chemistry attitude scores. These findings revealed that students' achievement in chemistry was raised by activities created using Web 2.0 tools.

Keywords: Web 2.0 applications, chemistry achievement, attitude towards chemistry, acids and bases, high school students

INTRODUCTION

Technology, particularly in education, enhances education's implementation by reaching broad populations, making learning easier and more enjoyable, and supporting the concrete acquisition of many subjects (Halili, 2018; Solomon & Schrum, 2007). Teachers and students are greatly affected by technological innovations in the education and training process. Teachers, who are among the essential components of education, should be well-versed in information technologies, pedagogical training, and specialized field knowledge to use technology at a level appropriate for the time, to have a firm grasp of the subject, to use appropriate methods/techniques when necessary, and to foster an interactive learning environment. (Hursen, 2021). Technology has become an integral part of our lives, shaping the learning environment, the classroom, and even the way teachers teach (Akpınar et al., 2005). One important factor in this regard is teachers' willingness to change and develop, interest in Web technologies, and proficiency with various Web tools. One of the technological tools that teachers can use in the education process is Web 2.0 applications. Internet technologies of today's age also referred to as Web 2.0 applications, provide advantages such as easy communication, fast information sharing and easy access to necessary data, active data design, information recording, measurement/assessment, and visualization, and are easily accessible to participants of all ages (Altun, 2008).

After a 2004 brainstorming session, Tim O'Reilly and Media Live International first developed the idea of Web 2.0. (Bozkurt, 2013). O'Reilly defined the concept of Web 2.0 as a revolution in the information world (Atıcı & Yıldırım, 2010). The first Web pages created were text-oriented and had a black and white form. The Web pages that emerged in this period are completely information-oriented. Since these Web pages, which are called Web 1.0, have little interaction and are only one-way, the message is transmitted directly from the creator to the receiver and the message cannot be changed. As a result, the Web 1.0 era describes a setting in which information is transferred unilaterally, there is no user involvement, and as a result, the user has no voice. In contrast to Web 1.0 technology, which allows information to be shown on screens in a read-only mode, Web 2.0 technology brings together lots of users in a social and active environment, focused on the same goal and making users engaged in an interactive environment. (O'Reilly, 2007). For this reason, the main feature that distinguishes Web 1.0 and Web 2.0 is that Web 2.0 applications can create an interactive environment for users. One of the conveniences of Web 2.0 applications is that users can share information without facing technical obstacles and at the same time, it provides a basis for collaborative and social interactive environments provided by the Internet (Horzum, 2010). In this context, Web 2.0 can be defined as a new-generation internet platform that is user-centred, offers users freedom of movement, and allows them to contribute to its content (Genç, 2010).

Since Web 2.0 applications provide an opportunity for interaction between users, they support constructivist educational philosophy, especially social constructivist learning theories (Chitanana, 2020; Conole & Alevizou, 2010; Lu et al., 2010). It is thought that the use of Web 2.0 applications, which can also be used in daily life, in

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the educational process will attract the attention of today's children born and raised in technology and enrich educational environments (Korucu & Sezer, 2016). As students are encouraged to participate and contribute to the content of the course in the classroom environment, Web 2.0 applications also offer users the opportunity to create content, manipulate content, control content and socialize (Horzum, 2007). It is also, economical due to the ease of digital preparation and the use of materials prepared with Web 2.0 applications (Tatlı et al., 2019).

The active use of Web 2.0 applications by students and teachers brings innovation to the educational environment and contributes to learning (Horzum, 2010; Laru et al., 2012). Gündoğdu (2017) concluded that the collaborative learning environment developed with Web 2.0 applications contributed positively to students' academic achievement, motivation, and reflective thinking skills for problem solving. Gürleroğlu (2019) examined the effect of using Web 2.0 applications by the 5E model in teaching the Force and Energy unit on the academic achievement, motivation, attitudes, and digital literacy of seventh-grade students. As a result of the research, it was concluded that the realization of science teaching with web 2.0 applications contributed to students' academic achievement and motivation; it did not contribute to their attitudes towards science and digital literacy, and student opinions about science teaching were generally positive. Similarly, Atwa et al. (2013) determined that Web 2.0 tools supported flipped learning environments increased students' academic achievement in physics teaching. Korucu (2020) tried to determine whether there was a significant difference in the academic achievement, digital empowerment status and inquiry learning skills of pre-service biology teachers who used digital story development tools, one of the Web 2.0 technologies, in the biology laboratory course. According to the results of the research, it was determined that the digital story development environment supported by Web 2.0 technologies increased the academic achievement, digital empowerment status and inquiry learning skills of pre-service biology teachers.

Göker and İnce (2019) examined the effect of using Web 2.0 applications on academic achievement in teaching Turkish as a foreign language. "Turkish in 3 Minutes", one of the Web 2.0 applications created for teaching Turkish as a foreign language, was used. As a result of the research, it was stated that those who learned the lesson with the Web 2.0 applications achieved higher academic success than those who learned the lesson with the traditional method.

In conclusion, it is obvious that Web 2.0 applications support educational environments and processes for both teachers and students (Demirel & Aslan, 2014). For this reason, especially in the teaching of science subjects that contain many abstract concepts, the effect of teaching with different Web 2.0 applications in which the student is included in the learning environment and the interaction between the student and the course material is provided should be investigated. This study aims to investigate the effect of course materials prepared with Web 2.0 applications on 10th-grade students' academic achievement and attitudes toward the chemistry course. For this reason, the academic achievement test results for the "Acids, Bases and Salts" unit and the results of the chemistry course attitude scale for the experimental group of students, who used course materials constructed using Web 2.0 applications, and the control group of students, who used the traditional teaching method, will be compared.

When the literature is examined, it is seen that there are no instructional materials created using course materials prepared with Web 2.0-based applications related to the "Acids, Bases and Salts" unit. Teachers often have difficulty finding materials while applying different methods and techniques in the classroom (K.Çoban et al., 2017). For this reason, this research is thought to be important in terms of giving teachers an idea about the materials that can be prepared by using Web 2.0 applications, as well as revealing the effect of Web 2.0 applications on achievement and attitude towards chemistry course and guidance to students, teachers, and researchers. In this context, the following questions were sought to be answered in this research.

1. Do course materials prepared with Web 2.0 applications in the "Acids, bases and salts" unit have an effect on 10th-grade students' academic achievement in chemistry course?

2. Do course materials prepared with Web 2.0 applications in the "Acids, bases and salts" unit have an effect on 10th-grade students' attitudes towards chemistry course?

METHOD

Within the scope of this study, the effect of course materials prepared with Web 2.0 applications on 10th-grade students' academic achievement of the "Acids, Bases and Salts" unit and attitudes towards chemistry course was investigated. For this purpose, the achievement test scores and attitude scale scores of the 10th-grade experimental group students in which course materials prepared with Web 2.0 applications were applied and the control group students in which traditional teaching method was applied were compared. The research design is a quasi-experimental design with the pretest-posttest control group, which is one of the quantitative research methods. A Quasi-experimental design is used in research to measure the effectiveness of any variable (a new program, learning method) and to make recommendations based on the findings of the measurement (Ekiz, 2016; Pallant, 2016).

In the study, Chemistry lessons were carried out with the traditional teaching method in the control group whereas the experimental group received instruction using course materials created using Web 2.0 applications. In the process, the Acids and Bases Achievement Test (ABAT) and Chemistry Course Attitude Scale (CCAS) were applied to all students as pre-test and post-test. The experimental plan applied in the study is given in Table 1.

Table 1. Experimental Plan

Groups	Pre-test	Practice	Post-test
Experimental	ABAT, CCAS	Instruction with materials prepared with Web 2.0 applications	ABAT, CCAS
Control	ABAT, CCAS	Traditional Teaching Method	ABAT, CCAS

Sample

This study was conducted in the spring semester of the 2021-2022 academic year. The sample of the research consists of 10th-grade students studying in a public high school in a district of one of Turkey's most populous provinces. This province was determined by a convenient sampling method and the school was determined by a simple random sampling method among schools in the province. There are 13 10th grades in the school. The sample selection of the research was made by randomly assigning any of the previously formed classes as an experimental and control group. There were 24 students in the experimental group, 10 girls and 14 boys, and 24 students in the control group, 13 girls and 11 boys. The school where the research was conducted is located in a socio-economically middle-level residential area. The students had not previously received any education that included course materials prepared with Web 2.0 applications. Each student has a cell phone that can be used individually. There is also a smart board with internet access in every classroom in the school.

Data Collection Tools

In this study, Acids and Bases Achievement Test (ABAT) and Chemistry Course Attitude Scale (CCAS) were applied to the participants as data collection tools. The data collection tools to be used in the research are tools whose validity and reliability have been predetermined. Permission was obtained by the authors to use these data collection tools in this research.

Acids and Bases Achievement Test (ABAT)

The Acids and Bases Achievement Test developed by Dinçol-Özgür (2016) to determine the achievement of gifted and talented 8th-grade students is a multiple-choice test consisting of 20 questions. The content and face validity of the test were examined by experts in the field of Chemistry Education and Science Education. Cronbach alpha coefficient (α) was used for reliability and this value was calculated as 0.822. Since the test was prepared for gifted and talented students, its suitability for the scope of this study was checked by one Chemistry Education expert and two Chemistry teachers, one of whom was the Chemistry teacher teaching in the experimental and control groups. It was stated that the achievement test was suitable for the acquisitions of the 10th-grade "Acids, Bases and Salts" unit and the student level. The Cronbach alpha coefficient (α) was determined as 0.79 after the test was applied to the participants.

Chemistry Course Attitude Scale

The scale developed by Cheung (2009) and adapted into Turkish by Şenocak (2011) aims to determine the Chemistry Course Attitudes of high school students aged 16-19. The scale is a Likert-type scale consisting of a total of 12 items and 4 dimensions. A seven-point Likert structure was used in the scale. In the studies, it was stated that seven-point Likert-type scales yielded more reliable data (Alwin & Krosnick, 1991). The reliability of the Chemistry Course Attitude Scale was examined based on Cronbach alpha (α) and item-total score relationships. While the Cronbach alpha value for the whole scale was found to be 0.88, the values for the four dimensions ranged between 0.68 and 0.84. As with the achievement test, the appropriateness of the attitude scale for the scope of this study was checked by one Chemistry Education expert and two Chemistry teachers. It was stated that the scale was suitable for this research. As a result of the application of the scale to the participants, the Cronbach alpha coefficient (α) was determined as 0.81 for the whole scale and 0.66-0.78 for the sub-dimensions.

Research Process

In the first stage, materials were developed with Web 2.0 applications in line with the learning outcomes of the Acids, Bases and Salts unit, taking into account the updated curriculum of the Ministry of National Education (Table 2). Table 2 shows the outcomes and the Web 2.0 applications used to achieve these outcomes. At this stage, at least three different Web 2.0 applications were used for each learning outcome and a total of 9 different applications (powtoon, bubbl.us, share.pixton, wordwall,learningapps, storyjumper, cram, quizizz, popplet) were used. When the literature was examined, it was determined that Yalçın-Çelik et al. (2021) divided the mobile applications used in the field of education into three groups as game-oriented, teaching-oriented and exam-oriented. In this study, 6% of the Web 2.0-based materials prepared in this study were for students to play games, 70% were for teaching the related subject and 24% were for evaluating the teaching process. All prepared materials were examined by the chemistry teacher who will carry out the teaching practices in groups in terms of chemistry content, suitability to the curriculum and applicability in the current school conditions. The materials were finalized by making the necessary arrangements by taking into account the opinions of the teacher.

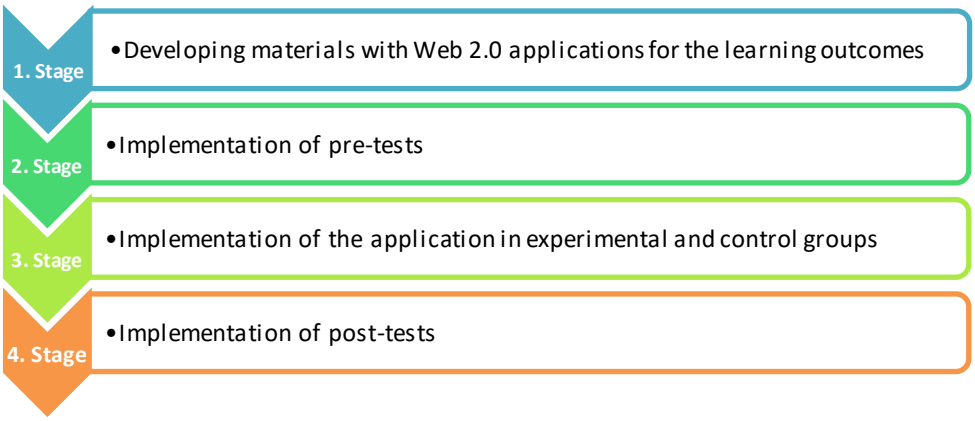

Figure 1. Research Process

In the second stage of the study, the groups were determined, and the "Acids and Bases Achievement Test" and "Chemistry Course Attitude Scale" were applied to both groups in the same week. These scale scores were evaluated as pre-test scores.

Table 2. Used Web 2.0 Applications According to Learning Outcomes

Learning Outcomes	Materials Prepared with Web 2.0 Applications
10.3.1.1. Distinguishes acids and bases with the help of their known properties.	1) https://www.powtoon.com/ws/ezv8N71tGAg/1/m 2) http://go.bubbl.us/b9ce81/d78e?/ASİTLERİN-ÖZELLİKLERİ 3) http://go.bubbl.us/b9cebb/3553?/New-Mind-Map 4) https://share.pixton.com/qumu3cd 5) https://www.powtoon.com/ws/es0HRXlYhzh/1/m 6) https://www.powtoon.com/ws/fMCfw667G3S/1/m 7) https://www.powtoon.com/ws/eR9WeSul8SV/1/m 8) http://go.bubbl.us/ba2600/33c1?/pH 9) https://wordwall.net/play/10186/141/242 10) https://wordwall.net/tr/resource/10186290 11) https://learningapps.org/display?v=p56sypvgn21 12) https://www.storyjumper.com/book/read/107561546/609c7ca0f2900 13) https://www.cram.com/flashcards/games/10-sinif-kimya-12203699
10.3.1.2. Explains the acidity and basicity properties of substances at the molecular level.	1) https://www.powtoon.com/ws/fFlXXvMdQgx/1/m 2) https://www.powtoon.com/ws/ed5pqFaXLll/1/m 3) https://share.pixton.com/qmc10ue 4) https://www.storyjumper.com/book/read/107651146/609d68af53ddf 5) https://learningapps.org/display?v=puzgf8yec21 6) https://learningapps.org/display?v=pnotvtyq321 7) https://learningapps.org/display?v=pgfackkmc21
10.3.2.1. Explains the reactions between acids and bases.	1)h ttps://www.storyjumper.com/book/read/107011116/609565e5b8c4d 2) https://youtu.be/jEFLY2EqSlw 3) https://learningapps.org/display?v=pimcymumc21
10.3.2.2. Explains the important reactions of acids and bases in terms of daily life.	1) https://www.storyjumper.com/book/read/107081486/6095d6149b0f2 2) http://go.bubbl.us/ba554b/f166?/New-Mind-Map 3)https://quizizz.com/join/quiz/60d8e2b4bc8be7001c23f5cd/start?student Share=true
10.3.3.1. Explains the benefits and harms of acids and bases.	1) https://www.storyjumper.com/book/read/107465626/609bcd16eaa67 2) http://go.bubbl.us/ba271e/0e6b?/New-Mind-Map 3) http://go.bubbl.us/ba27a4/3dfa?/Start 4) http://go.bubbl.us/ba3fb7/faa1?/KİRECİN-VE-KOSTİĞİN-YAĞ,
10.3.3.2. Explains the health and safety precautions to be taken when working with acids and bases.	1) https://www.storyjumper.com/book/read/107489976/609bf34955dc6 2) app.popplet.com/#/p/6550874 3) https://www.youtube.com/watch?v=s1qFNUatLQg
10.3.4.1. Explains the properties and uses of salts.	1) https://www.powtoon.com/ws/eVEjOnK0JEj/1/m 2) http://go.bubbl.us/b93bea/550e?/New-Mind-Map 3) https://www.storyjumper.com/book/read/105597386 4) https://learningapps.org/display?v=p195hvw0t20 5) https://www.cram.com/flashcards/games/10-sinif-kimya-12203752

In the third stage, in the experimental group, lessons were carried out with teaching materials prepared using Web 2.0 applications. Students were typically given opportunities to participate in these materials, and it was encouraged that they participate in activities that incorporated their perspectives and promoted engagement. Figure 2 shows examples of materials used during the course. The teaching material prepared with Wordwall application is for the learning outcome of "Distinguishes acids and bases with the help of their known properties" (Figure 2. a). This application was preferred to make the lesson more fun by allowing students to play games. After the lecture on the general properties of acids and bases was completed, students were provided with a game to reinforce the subject matter. A Word wall application named "hit the compounds expressing acids " was opened on the smart board. Students played the game in groups. The material prepared

with the Learning Apps application is for the learning outcome of "Explains the acidity and basicity properties of substances at the molecular level" (Figure 2. b). This application was preferred to make the subject more fun and memorable. After the lecture was completed using Web 2.0-based materials, this application was used in the evaluation phase. The evaluation phase was completed with the active participation of the students.

Similarly, the PowToon application was used in the introductory phase of the lesson to prepare video lectures to attract students' attention and motivate them to the topic. Bubbl.us, pixton, story jumper and pooplet were used to emphasize what was learned. Word wall, learning apps, quizizz and cram applications were used in the evaluation phase of the course to measure students' understanding of the subject.

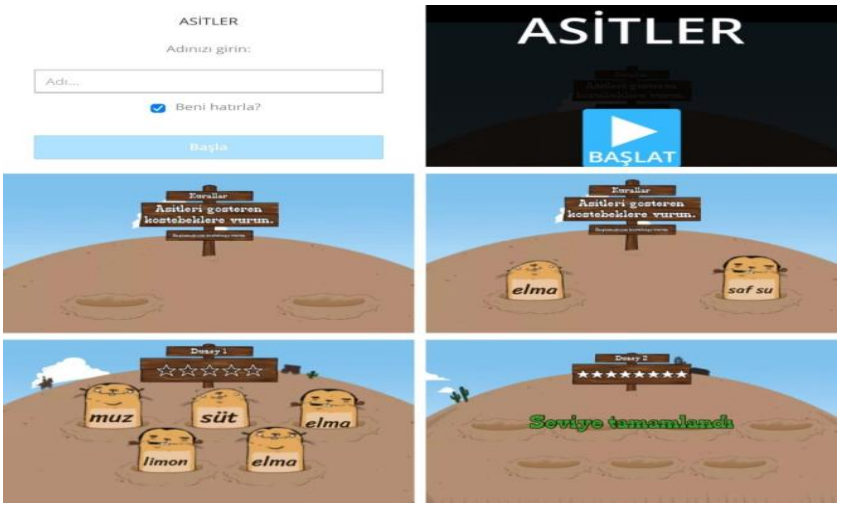

Figure 2.a. Teaching material prepared with Wordwall Application

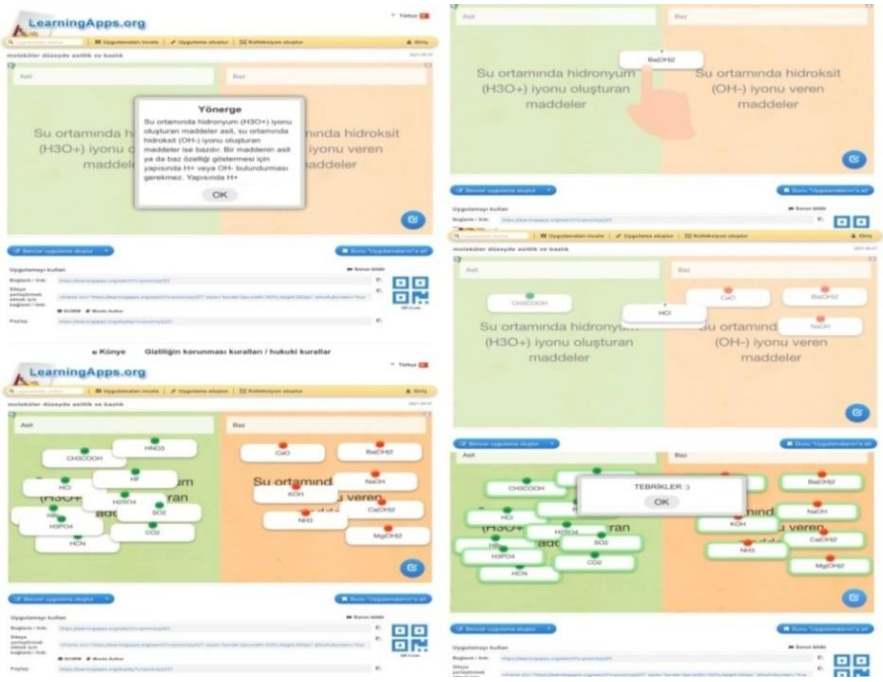

Figure 2.b. Assessment material prepared with Learning Apps Applications

Figure 2. Examples of Materials Prepared with Web 2.0 Applications

Traditional teaching methods continued in the control group according to the updated curriculum of the Ministry of National Education. The same chemistry teacher conducted the lessons for both groups. One of the researchers met with the teacher every week before the lessons and provided training on how to apply the prepared materials. The researcher was present in the lessons as an observer. The 6-week training process was completed in 9 weeks due to the writing week, mid-term vacation and holiday break. After the instruction, the same scales were administered to both groups again as a post-test and the fourth stage of the research was completed.

Data Analysis

To determine the effect of teaching with materials prepared with Web 2.0 applications on high school students' achievement and attitudes towards chemistry courses, ANCOVA analysis was applied to the ABAT and CCAS scores of the experimental and control groups using the SPSS 26 package program. ANCOVA analysis is used to assume that the participants are not randomly assigned to the groups and as a result, the groups are "equal" at the beginning of the study. The first assumption of ANCOVA analysis is that the test scores of the groups are normally distributed. The other assumptions are the equality of covariance and homogeneity of variance (Büyüköztürk, 2021; Pallant, 2016). Assumptions were checked for the analysis, and it was determined that the assumptions were met for analyses.

FINDINGS

The findings are presented under the headings of (i) findings related to academic achievement and (ii) findings related to the attitude in line with the analysis of the data obtained in the study.

Findings on Academic Achievement

To determine whether there was a significant difference between the achievement scores of the experimental group students who were taught with Web 2.0 applications and the control group students who were taught traditionally, the achievement pre-test scores of the students in the experimental and control groups were taken under control and the post-test scores were compared. The descriptive statistical values of the pre-test and post-tests conducted to determine the achievement status of the experimental and control group students after the application are given in Table 3.

Table 3. Achievement test descriptive statistics results

		N	$\bar{X}$	sd	Minimum	Maximum	Skewness/ Kurtosis
Control	Pre	24	4.2917	2.56191	1.00	10.00	.881 / .009
	Post	24	7.1250	3.28782	2.00	14.00	.608 / - .264
From	Pre	24	6.1667	2.72934	2.00	11.00	.173 / - .946
	Post	24	11.3333	2.85393	6.00	17.00	.306 /- .067

When Table 3 is examined, a difference is observed between the pre and post-test mean scores of both groups. To understand whether this difference is statistically significant, ANCOVA analysis was applied by controlling the pre-tests (Table 4).

Table 4. ANCOVA analysis results of achievement test

Source of variance	Sum of squares	sd	Mean Squares	F	P	Eta-Square (η^2)
Achievement Pre	4.431	1	4.431	.462	.500	.010
Group	168.799	1	168.799	17.603	.000	.281
Error	431.527	45	9.589			
Total	4737.000	48				

When Table 4 is examined, according to the results of ANCOVA analysis, it was determined that there was a statistically significant difference between the achievement posttest scores of the experimental and control groups [$F(1,45)=17.603$, $p< .05$, eta square (η^2)= .281]. To determine which group the difference was in favour of, the adjusted posttest mean scores of the groups were taken into consideration. Accordingly, it was determined that the mean post-test scores of the experimental group students ($\bar{X}$= 11.223) were higher than the mean post-test scores of the control group ($\bar{X}$ = 7.235). In other words, the education realized with the materials prepared with Web 2.0 applications had an effect on the chemistry achievement of the students. According to the eta-squared value (η^2 = .281), the effect of the method explains 28.1% of the difference in the post-test scores. Eta-squared value is the expression showing how much of the variance in the dependent

variable is explained by a certain independent variable. In this value, .01 is considered a low effect level, .06 as an average effect level, .14 and above as a large effect level (Büyüköztürk, 2021; Pallant, 2016). In this case, it was determined that the teaching applied with Web 2.0 applications to the experimental group students had a large effect value.

Findings on Chemistry Course Attitude

To determine whether there was a significant difference between the attitude scores of the experimental group students who were taught with Web 2.0 tools and the control group students who were taught traditionally, the attitude pre-test scores of the students in the experimental and control groups were taken under control and the post-test scores were compared. The descriptive statistical values of the pre-test and post-test to determine the attitudes of the experimental and control group students after the application are given in Table 5.

Table 5. Descriptive statistics results of an attitude test

		N	$\bar{X}$	sd	Minimum	Maximum	Skewness/ Kurtosis
Control	Pre	24	39.2083	12.44109	12.00	60.00	-.715 / .010
	Post	24	42.3333	12.46444	12.00	61.00	-.875 / .245
From	Pre	24	39.4583	15.34807	12.00	65.00	-.051 / -.583
	Post	24	45.2917	13.28444	24.00	77.00	.585 / -.091

When Table 5 is analyzed, a difference is observed between the posttest mean scores of both groups. ANCOVA analysis was applied to see whether this difference was statistically significant (Table 6).

Table 6. Attitude test ANCOVA analysis results

Source of variance	Sum of squares	sd	Mean Squares	F	p	Eta-Square (η^2)
Attitude Pre	1964.002	1	1964.002	15.592	.000	.257
Group	96.875	1	96.875	.769	.385	.017
Error	5668.289	45	125.962			
Total	99875.000	48				

When Table 6 is examined, according to the results of ANCOVA analysis, it was determined that there was no statistically significant difference between the attitude posttest scores of the experimental and control groups [$F(1,45)= .769$, $p> .05$, eta square (η^2)= .017]. In other words, training with materials prepared with Web 2.0 applications did not affect students' attitudes towards chemistry course.

CONCLUSION and DISCUSSION

In this study, which investigated the effect of course materials prepared with Web 2.0 applications on 10th-grade students' academic achievement and attitudes towards chemistry course, it was determined that the use of Web 2.0-based applications in chemistry course teaching caused a significant difference in students' achievement towards the course but did not cause a significant difference in their attitudes towards the course.

The change in 10th-grade students' achievement in Acids, Bases and Salts unit was determined by comparing the achievement test averages of the experimental and control groups. When the achievement test results of the experimental and control groups after the application were compared, it was determined that there was a significant difference between the achievement scores of the experimental group students in which Web 2.0 applications were used in chemistry course teaching. Similarly, many studies have shown that Web 2.0 applications have a significant impact on students' academic achievement (Akkaya, 2019; Almalı, 2020; Can, 2021; Demirel & Aslan, 2014; Köse et al. 2021; Türegün et al., 2022). For example, in Köse et al. (2021) study investigating the effect of Web 2.0 applications -supported argumentation on the academic achievement of secondary school students on the subject of force and energy, they determined that the experimental group students were more successful than the control group students. Türegün et al. (2022) found that the use of Web 2.0 tools in the distance education process increased vocabulary learning achievement in English lessons.

It is obvious that Web 2.0 applications support educational environments and processes for teachers and students. It is thought that Web 2.0 tools affect students' academic achievement because Web 2.0 applications can include students in the learning environment with games and fun in teaching subjects such as science, especially those that contain many abstract concepts, and in making sense of concepts for students. There are studies in the literature that support our claim. For example, Can (2021) claims that the use of Web 2.0-supported conceptual cartoons in science courses has a positive effect on academic achievement because they are different and fun for students and increase interest and motivation towards the course. Similarly, Bilgican-Yılmaz et al. (2021) stated that Web 2.0 applications can support learning to provide active learning in subjects that are difficult to learn, making the session enjoyable for the students, attracting their attention by appealing to many senses, and to ensure understanding and retention of the subject. There are studies indicating that educational games are effective in increasing achievement in science teaching. In the study conducted by Yazıcıoğlu and Çavuş-Güngören (2019), it was determined that the use of game-based activities in science teaching improved the academic achievement of middle school students. Similarly, Serdaroğlu and Güneş (2019) stated that the lesson taught with educational games in the 6th-grade science course positively affected the academic achievement of the students as they learned the lesson with fun and enjoyment. Şentürk (2020) explained the effect of game-based science teaching and learning experiences on academic achievement based on the fact that students learn by having fun, actively, doing-living during the lesson process, undertaking tasks and responsibilities, and developing positive attitudes towards the course. Another study by Uslu (2022) found that at a certain level, pupils who differ in ability, interest, perception capacity, achievement, motivation, readiness, and learning style come together and their differences vanish. In other words, it was determined that students with low academic achievement can be activated during the game compared to other students in the class to increase their achievement and make sense of the information learned. As a result, teaching concepts with various game activities in courses that include abstract concepts such as chemistry lessons facilitate the understanding of these concepts. In this study, which was conducted with the unit of Acids, Bases and Salts, various Web 2.0 applications (wordwall, learningapps, cram) were used to ensure the retention of abstract concepts, to enable students to learn with fun and to increase classroom activity. Game activities were prepared with Web 2.0 applications for the learning outcomes created by the Ministry of National Education related to the unit. It is thought that such activities increase students' interest in the lesson and affect their academic achievement.

When the 10th-grade students' Chemistry course attitude scores were examined, it was determined that the instruction with the materials prepared with Web 2.0 applications did not affect the Chemistry course attitude scores. The reason for this may be that changing or forming students' attitudes is a process and the implementation period of this research was insufficient to create a change in the attitudes of high school students towards chemistry course. As stated in the method section of the research, although the instruction with Web 2.0 applications in the experimental group lasted for 9 weeks, the instruction could not be realized for 3 weeks for different reasons. In other words, in the 9-week research process, breaks had to be given due to unavailable reasons. For this reason, interest and motivation towards the lesson may have decreased. As a different result, in the 9-week study conducted by Can (2021) on the use of concept cartoons in science education, it was determined that instruction with Web 2.0 applications had an effect on the attitudes of the experimental group students towards the Chemistry course. According to Can (2021), it was stated that Web 2.0-supported conceptual cartoons helped students develop positive attitudes towards the course because they facilitated and concretized the course by saving the science course from being difficult and abstract. This result shows that attitude, which is one of the affective characteristics, changes in studies with a long implementation process. The results of the studies in the literature are similar to the results of this study. For example, Aymen-Peker and Yalçın (2018) found that the design including the jigsaw technique did not have a significant effect on students' attitudes towards science courses and science learning approaches in a study lasting 6 lessons hours. In a similar study, Gürleroğlu (2019) found that 5-week science teaching with Web 2.0 applications did not effect on students' attitudes towards science. In another study, Uysal (2020) found that the use of Web 2.0 animation tools in a 6-week science course did not have any effect on students' attitudes towards science. When the literature is examined, it is mentioned that attitude can occur as a result of long-term teaching for it to be permanent and behaviour change to occur (Karamustafaoğlu, 2003). As a result, it is thought that the research process was insufficient when the attitude towards the chemistry course was examined.

SUGGESTIONS AND LIMITATIONS

Considering all these findings, the inclusion of Web 2.0 applications in the learning environment increases achievement and promises to develop positive attitudes towards the course. Teachers have a serious responsibility for the use of such applications. Studies that investigate the problems encountered in the preparation of such materials, especially with teachers and pre-service teachers, are recommended. In addition, a limitation of this study is that it was conducted with a small number of high school students only in the acid-bases and salts unit. For this reason, the results of longer studies with more participants would be valuable for the literature. In particular, it can be recommended to other researchers examine the effect of using Web 2.0-based applications on attitudes in longer-term studies.

This study investigated the effect of Web 2.0-supported teaching applications on high school chemistry students' academic achievement and their attitudes towards chemistry courses in the "Acids, Bases and Salts" unit. In the research, course materials were prepared by choosing Web 2.0 tools that are freely accessible and practical to use. However, there are different Web 2.0 applications for developing course materials. Since the results of this research are related to 9 different Web 2.0 tools employed, using only these tools is the limitation of the research. This is another limitation of this research. Researchers can renew the application with different Web tools and even investigate which types of Web tools contribute to the teaching process.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the author(s) with respect to the research, authorship, or publication of this article.

Ethics Approval

The formal ethics approval was granted by the Publication Ethics Committee of Gazi University (Number: E-77082166-302.08.01-85662).

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Research and Publication Ethics Statement

The study was approved by the research team's university ethics committee of Gazi University (Approval Number/ID: E-77082166-302.08.01-85662. Hereby, we as the authors consciously assure that for the manuscript "The Use of Web 2.0 Applications in Chemistry Teaching: Acids, Bases and Salts Unit" the following is fulfilled:

- This material is the authors' own original work, which has not been previously published elsewhere.
- The paper reflects the authors' own research and analysis in a truthful and complete manner.
- The results are appropriately placed in the context of prior and existing research.
- All sources used are properly disclosed.

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