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A Picture of Chemistry: A Case Study from High Schools (Hakkari Sample)

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Abstract

This research aims to draw a picture of chemistry lessons based on students' opinions in Hakkari, Turkey. The research design is a case study. An open-ended qualitative questionnaire consisting of 15 questions was used. The questionnaire was applied to 463 tenth- and eleventh-grade students studying at high schools in Hakkari. The data obtained were analyzed using qualitative and quantitative methods: content analysis, correlation tests, and chi-square tests. As a result, two categories were found: the factors affecting chemistry teaching and the effect of chemistry on students' daily and future lives. According to this, students' interest in chemistry is a factor in learning chemistry, the teaching method used by the teacher is an essential factor for chemistry, and having enough knowledge of chemistry affects achievement in other courses. A significant difference was found between female and male students choosing chemistry in their future careers, and the results were in favor of male students. On the contrary, female students thought that chemistry would be more permanent than males thought in their lives. The activities used in chemistry lessons, teachers' attitudes in the classroom, and the use of chemistry examples in daily life are effective for learning chemistry and choosing chemistry for a future career.

Keywords: chemistry teaching, teachers' effects, science teaching

1. The Importance of Science

One of the realities of the era in which we live is that science and technology are developing rapidly This development has brought about tremendous changes. Individuals need to adapt to this change in every field because, with the adaptation of individuals, there is harmony on a social basis. This means the following generation of civilization in the globalizing world. It is possible for this change to be of good quality only by understanding science, and understanding science will be possible with good-quality education. Science education is provided in educational institutions so that individuals can make sense of events and phenomena in nature and solve the problems they encounter in nature and in their environments. According to Hançer, Şensoy and Yıldırım (2003), one of the main purposes of science education is to raise individuals who can keep up with the rapidly changing and developing science age and who can benefit from the latest technological inventions in every field. Another purpose is to enable individuals to learn that science is necessary in all technological inventions and developments (Güneş & Karaşah, 2016). Chemistry, which is an important part of daily life, in order to practice their chemical knowledge to evaluate the risk assessments of processes and products related to existing socio scientific and ethical issues in the world (Sevian & Bulte, 2015, p. 55), has a very important place in science education. In order for students to make sense of what is happening in the outside world and to explain it scientifically, they should have good chemistry knowledge, as in other branches of science. Chemistry teachers who play an important role in chemistry education need different resources and opportunities, such as coming up with real life socio scientific issues, having training related to innovative and also digital teaching methods. These teachers should have the skills necessary to use the technology required in the current era and to use the methods of learning-by-doing and experiencing through in-class practice. When looking at developed countries, student-centered practices for chemistry teaching come to the fore. When studies are examined, it is clear that chemistry course is considered a difficult course in general. In his study of the difficulties encountered in learning chemistry, Sirhan (2007) said that chemistry is "often regarded as a difficult subject, an observation that

sometimes repels learners from continuing with studies in chemistry. With the establishment of new syllabuses in chemistry for secondary schools in different countries in the last decayed" (p. 3). In order to make progress in chemistry education, learning environments at both the secondary and university levels must be revised. In the Finnish education system, which is the most successful among the education systems in the world, students' opinions are utilized when making changes in learning environments. Administrators, teachers, and students can make decisions together. While preparing the course content, the curriculum can be arranged by taking into account the opinions of the students regarding the current courses, and the course content can be made more attractive. In this way, with good-quality science education within the dimension of chemistry lessons, it will be possible to raise individuals who have literacy in, sensitivity to, and awareness of science.

1.1 Studies on Students' Opinions of Chemistry

When the relevant literature is examined, it is seen that the views of teachers about chemistry lessons are more prominent than those of students. Therefore, there are not many studies in the related literature that discuss students' views of chemistry lessons. There are studies in which students' opinions are mostly discussed after applied or experimental procedures. Çevik and Yücel (2009) examined students' views about computer-assisted chemistry teaching in their applied study. Moreover, in their research, Baran and Sözbilir (2017) examined students' views about this process by using the context-based learning approach. Rosly, Hamid and Rahman (2021) examined students' views of organic chemistry courses. In these studies, the students stated that they had difficulty with chemistry lessons. Berger (2015) examined students' views about chemistry laboratories and reported that students' laboratory perceptions affected their perceptions of chemistry. Similarly, Sneddon and Hill (2011) stated that students' perceptions of chemistry laboratories affected their attitudes toward chemistry. On the other hand, Sirhan (2007) found that students' views were important factors that played a key role in chemistry teaching. Yıldırım and Maşeroğlu (2016) stated that student-centered practices had positive effects on associating students' chemistry knowledge with daily life.

1.2 Chemistry Education in Turkey

Science plays a very important role in the development of countries. Individuals who grow up with good-quality science education in schools can play an active role in developments in science and technology in the world, especially in economic terms. Chemistry courses taught at the secondary school level are also important components of science education. The chemistry courses curriculum in Turkey was revised by the Ministry of National Education in 2017. The rapid change in science and technology, the changing needs of individuals and, therefore, of society, new student-centered approaches used in learning environments, and roles expected from individuals were all shown as the reasons for this revision (Yuliani & Hartanto, 2017). With this change, individuals will be able to produce information, use it in their daily lives, and solve problems they encounter. The curricula that will help raise individuals with this quality were prepared in a simple structure, which takes into account individual differences and aims to convey values and skills rather than merely conveying information (Milli Egitim Bakanlig (MEB), 2018).

Despite the fact that the renewed chemistry curriculum is officially in practice in secondary education institutions in Turkey, studies report that there are actually various problems in its implementation. In a study of chemistry teachers, Yıldırım and Canpolat (2013) stated that there were various problems in the applicability of the chemistry curriculum. Studies have revealed that problems exist in practice both because of the impossibilities in the learning environments such as the physical conditions of classrooms, lack of science laboratory and digital equipments and because of the attitudes of the teachers. the country-wide university entrance exam at the end of secondary education in Turkey, which via multiple choice questions, force students to memorize without learning deeply, is an important factor in students' prejudice toward context-based learning approaches (Baran & Maskan, 2010). The chemistry course, which is one of the most important courses in science education, provides in-depth information for understanding nature by examining the nature and behavior of matter.

> Thanks to its being an applied science and its philosophical foundations, chemistry has a central position among the branches of science. The birth of chemistry started with the first steps of civilization. The knowledge and science of Chemistry are at the core of the humanity's efforts to understand the world. Today, chemistry knowledge is used in many different fields, from understanding the structure of living things to the solution of environmental problems. Chemistry is directly or indirectly present in all stages of our lives, such as health, food, agriculture, animal husbandry, transportation. The fact that chemistry is closely related to almost all branches of science and that it continuously exists in our lives, albeit in different forms, causes individuals to perceive and interpret the concept of chemistry in different ways (Anılan, 2017).

With good-quality chemistry education, high school students can become more interested in chemistry, and their

levels of success in chemistry can increase. Students are the most important component of the educational process. The attitudes, beliefs, and opinions of students toward courses should be taken into consideration, and the curricula should be revised when necessary, taking these situations into account. This also applies to chemistry classes. In order to develop more effective and good-quality chemistry curricula, it is thought that students' views should be evaluated and analyzed well (Rohandi, 2017; Sevian & Bulte, 2015, p. 56).

1.3 Importance of the Study

According to the related literature, in-depth studes were conducted with high school students regarding their chemistry courses; however, it couldn't find research on the students' perceptions toward chemistry. In this respect, in this study, students' views about the chemistry course were analyzed in depth along with their reasonings. At the same time, the results of this study will make it easier to look at chemistry lessons through the eyes of students and to empathize. Taking students' views, beliefs, and knowledge into consideration will guide planners and developers in developing a more effective curriculum. It is thought that students, who are the most important components of the education system, should understand and adopt chemistry course and have positive views and beliefs in order to conduct chemistry courses in a better way (Mahdi, 2014; Sevian & Bulte, 2015, p. 56). Otherwise, it cannot be expected that chemistry courses will be conducted effectively (Arthur, 2019; Rohandi, 2017; von-Rhöneck et al., 2007; Bamber & Anderson, 2012). In this study, students' views on chemistry lessons, were determined from various perspectives. Based on the students' views, analyses were conducted on various aspects, such as how chemistry lessons were perceived by students, the effect of chemistry on their future, and the effect of gender on their interest in chemistry lessons. It is thought that the analyses of the opinions of the students, who should be the main interlocutors in the education system, about chemistry courses will enrich the related litrerature and guide researchers who do research in this field (Rohandi, 2017; Tomlinson, 2017)

1.3.1 Purpose of the Research

This study aimed to determine the opinions of high school students about chemistry courses It is expected that the findings obtained at the end of the study will contribute to the development of chemistry education.

1.3.2 Research Questions

1) What are the factors affecting learning in chemistry courses?

2) What is the importance of chemistry in the daily and future lives of the students participating in the study?

2. Method

The case study method, a qualitative research method, was used in this study. Case studies allow to focus in depth on a "case" and retain a holistic and real-world perspective (Yin, 2018). High school students taking chemistry lessons in Hakkari were the main elements of our case study. Within this physical framework, city of Hakkari, the ideas of these students about learning chemistry were analyzed in detail.

2.1 Data Collection Tools

The data collection tool in this study uses fully open-ended questions. Fully structured, open-ended questions are predetermined and standardized. These questionnaireaim to identify and compare the similarities and differences between the information given by students (Yildirim & Şimşek, 2016). For this reason, open-ended questionnaires were used in this study to systematically identify similarities and differences between the students' views. In the study, open-ended question forms consisting of 15 questions were used.

2.2 Sample

The research sample was made up of 463 tenth and eleventh grade students (n = 260 and n male = 199; 4 students who participated in the study did not specify their gender) from 4 different high schools in the city of Hakkari in spring 2019. The research sample was determined using the convenience sampling method. The reason why the sample consisted of tenth- and eleventh-grade students was that all of the students had taken the chemistry course in the ninth grade and that at the time of the study, the twelfth-grade students were preparing for the national exam for university placement.

2.3 Data Collection and Data Analysis

In order to conduct the research process, necessary permission was obtained from the National Education Directorate of Hakkari Province. The schools were determined to be easily accessible and convenient. The dates for contacting the schools and for applying the open-ended question forms were determined. The questionnaires , were applied to each class within one class hour (45 minutes) as the data collection tool in the study.

The data obtained were analyzed using the content analysis method—a qualitative analysis method. The purpose

of content analysis is to research concepts and relationships that can explain the data obtained through the opinions of the participants, files, and document review (Yıldırım & Şimşek, 2016). To increase the external validity of the qualitative research, a detailed description of findings was provided. A detailed description allows for the "transferring [of] the raw data in a rearranged form based on the emerging concepts and data, without adding any comments to the reader and by sticking to the nature of the data" (Yıldırım & Şimşek, 2016, p. 282). In this approach, the aim is to present the data obtained as a result of an interview and observation to the reader in an organized and interpreted manner, and themes and categories were determined. To ensure the validity and reliability of the data analysis, a comparative analysis was conducted with another expert working in the same field, and common themes and categories were determined. In order to show which students represented which view, the students were coded as S1, S2, S3, and so on.

In addition, the research data were converted into quantitative data, coded in accordance with statistical analysis, and analyzed using Statistical Package for the Social Sciences (SPSS) 27. In the statistical analysis, the chi-square test and correlation test were used to examine the gender variance between the data.

2.4 Validity and Reliability of the Research

While determining the questions for the open-ended questions form, the relevant literature abut students views on science courses and particularly on chemistry courses was reviewed, and questions were formed. The prepared forms were analyzed by five experts working in the science education field, and the pilot study was applied to ten high school students. Based on feedback from the students, the final version of the open-ended question form was prepared.

The content analysis of the data obtained from the study was conducted comparatively by two experts, and the categories and codes were determined. As a result of the analyses conducted, the codes determined by the two researchers were compared, and a consensus of 91% was reached.

3. Findings

As a result of the analysis of the qualitative and quantitative data, it was seen that the data obtained were organized under two main headings:

Factors affecting learning in chemistry courses are as follows:

- The effect of interest in chemistry on learning chemistry
- Teacher's effect on learning chemistry
- Effect of chemistry on other courses
- The effect of mathematics and problem-solving skills on the teaching of the chemistry course

The importance of chemistry in students' daily and future lives is as follows:

- Whether the student chooses a department related to chemistry while planning their career, and the effect of the variable of gender on his/her preferences
- Importance of the development of chemistry courses in daily life

The students' perceptions of chemistry and the factors affecting their perceptions are shown in detail in Table 1.

Table 1. Students' views of chemistry courses

Category	Code	Explanation
Factors affecting learning in the chemistry course	Interest in chemistry	Chemistry really interests me, because the things that happen in our lives, that is, around us, take place in the book, so it interests me so much, I have always wanted to read and understand it (S348).
	Teacher	It is the teacher who makes the chemistry lesson fun, and if the teacher makes the lesson fun and interesting, the lesson will be great (S54).
	Effect of chemistry on other courses	I find the chemistry course positive. It helps me in physics and mathematics because formulas are in every lesson (S12).
		Yes, mathematical operations. It increases my ability. It has an effect on mathematical lessons (S431).
		Yes, it has an effect. Because I love chemistry, I want to be good at physics, biology, and mathematics, and I am doing it (S43).
	Mathematical skills	In chemistry class, I have difficulty depending on the subject. If we can do operations related to mathematics, we will do the operations in chemistry, too, and our chemistry will be good (S34).
The importance of chemistry in students' daily and future lives	Career plan	I don't have a preference for chemistry because I don't understand anything when I listen to the lesson, and I don't understand when I study the subject myself. Therefore, a person is too far away from a lesson that s/he cannot be successful (S434).
	Keeping up to date with developments in chemistry	It is useful to know the structure of newly produced medicine, detergents and perfumes (S13).
		It helps with how we can store our food for a long time (S350).

As can be seen in Table 1, the students' perceptions of chemistry depended on their interest in chemistry, mathematical skills, problem-solving skills, whether they preferred chemistry professions in their future career plan, and whether they used their knowledge of chemistry in their daily lives.

3.1 Factors Affecting Learning in Chemistry Courses

In light of the data obtained, factors obtained in learning chemistry are grouped under the headings of interest in chemistry and mathematical and problem-solving skills.

3.1.1 The Effect of Interest in Chemistry Courses on Students' Perceptions of Chemistry

As a result of the statistical and descriptive qualitative analysis of the data obtained, the students' interest could be said to have an influence on the following:

- Achievement
- Permanence of chemistry knowledge after school
- Attitudes toward chemistry
- Whether there will be a choice to pursue chemistry in the students' future careers

As a result of the analysis of the quantitative and qualitative data, most of the students (62%, n = 285) stated that they were interested in chemistry. In addition, when the effect of gender on attention was examined, there was no significant difference between male and female students ($p = 0.875$).

As a result of the quantitative analysis, 51% (n = 201) of the students stated that they were interested in chemistry lessons and therefore felt successful; however, as a result of another correlation analysis, 80% of the students who were not interested in chemistry lessons had difficulty in this course and failed because they were not interested.

S218, who was interested in chemistry class and felt successful, emphasized curiosity and reported his/her views as follows: "I am interested in chemistry because it is a science that includes mathematical operations. I love and have curiosity about these lessons, and I study with pleasure to satisfy my curiosity" (S218).

In the above statement, S218 pointed out that the reason for his/her interest in chemistry stemmed from his/her interest in science and mathematical operations. Based on this statement, it could be stated that s/he had a positive attitude toward chemistry.

S428, who felt unsuccessful because s/he had no interest in chemistry, reported his/her thoughts as follows:

> Chemistry is a complicated and boring course. Actually, chemistry is a very important course from a scientific point of view, but I think that the things provided in the course are unnecessary and fabricated most of the time. Physics and biology are much more logical and easy-to-understand courses (S428).

Considering the above statement, although S428 considered chemistry important, s/he had difficulty seeing the logical side of chemistry and therefore found it irrelevant, fabricated, and unnecessary. This student considered it confusing and boring because it was not easy to understand.

Another student reported that s/he was interested in a chemistry career plan: "Yes, because I love chemistry and I want to be a chemical engineer, it would be fun to deal with something and draw a conclusion in a laboratory in the future" (S43).

Based on this comment, it could be concluded that s/he liked chemistry; that is, s/he had a positive attitude. Moreover, s/he thought it would be fun to work in a laboratory and to choose this profession, referring to the practical dimension of chemistry.

Another student, emphasizing the relationship between chemistry and daily life, reported his/her interest as follows: "Chemistry really interests me because the things that happen in our lives, that is, around us, take place in the book, so it interests me so much I have always wanted to read and understand things about chemistry" (S348).

It could be stated that S348 was able to establish and make sense of the relationship between real life and chemistry, and therefore s/he could be said to be interested in chemistry.

As seen in the students' statements, the students' interest in chemistry has an impact on their success. Interest in chemistry could develop in line with the student's ability to relate chemistry to real life, the student's attitude toward chemistry, and, depending on whether the student found chemistry useful in his/her future life.

3.1.2 Do You Find Chemistry Classes Fun?

When students were asked whether they found chemistry lessons enjoyable in relation to their interests, there was no significant difference between boys and girls ($p = 0.124$) as a result of the quantitative analysis. Of all the female students, 60% ($n = 154$) stated that they found chemistry lessons enjoyable, while 57% of the male students said they found the lessons enjoyable.

Considering the effect of interest in chemistry on whether the course was enjoyable or not, it could be stated based on both quantitative and qualitative data that this situation was clearly in favor of the students with a high level of interest in chemistry. Approximately 74% ($n = 212$) of the students with a high interest in chemistry reported that they liked the chemistry course and found it enjoyable; however, 64% of the students who were not interested in chemistry stated that they did not find chemistry fun.

In response to the questionnaire questions the students who found the chemistry course enjoyable mentioned factors such as the relationship of chemistry with real life and the chemistry teacher.

S15 and S21, who were interested in the chemistry course and who found it amusing and related it to real life, expressed their thoughts as follows: "It's sometimes fun because we learn what kind of elements and substances are in perfumes, detergents, and foods" (S15). "The chemistry course is fun because the teacher always gives examples from daily life" (S21).

Based on the above statements, the students associated chemistry with real life, gave real-life examples, such as perfumes, detergents, and the content of foods, and found it amusing.

Emphasizing the course content and the teacher, S13 stated that s/he found chemistry entertaining: "I find it amusing because I like the teacher and enjoy dealing with atoms, elements, and formulas" (S13).

With the above comment of S13, the student thought that the course's teacher made the course content entertaining by referring to the course's importance and related elements and formulas.

On the other hand, the students who were not interested in chemistry and who said they did not find it amusing stated that this was due to factors such as the intense curriculum, lack of sufficient focus on the subject, difficult and boring content, the way lessons were conducted, and lack of laboratories.

S350 and S28, who did not find chemistry fun due to the fact that the curriculum was intense, reported their views as follows: "We always have difficulty keeping up with the syllabus; that's why we get bored" (S350). "The curriculum should not be so intense" (S28).

Based on the above comments, it could be concluded that students forund these courses and the curriculum intense and hadr to follow.

The students who reported that the course was not fun attributed this to the content of the lessons, formulas, and mathematical subjects, saying, "I don't find it fun at all because there are always formulas mentioned" (S349). "No, it's not fun, because I'm not good at mathematics; for example, it would be very fun if the mathematical parts were removed" (S44).

S349 and S44 had difficulties in chemistry because of the formulas and the subjects that required mathematical skills, and they did not find the chemistry course enjoyable.

The students who complained about the way the chemistry course was taught reported that this was an important factor in finding the course enjoyable. The students who stated that it would be more fun to teach the course outside of the classroom environment expressed their thoughts as follows: "I don't find the lessons fun; it would be nicer if it was done in the garden" (S415). "The way the course is taught might change. We could do it in the garden" (S418). "It could be more fun if we do the lessons in nature or in the laboratory" (S39).

As can be understood from the comments of S415, S418, and S39, the students favored chemistry lessons in the garden, inside a natural environment, and outside the classroom environment.

The students who favored teaching the course using more practical activities or in the laboratory expressed their thoughts about this situation as follows: "We can't use a laboratory because we don't have it. I guess that's why I don't like chemistry. It would be fun if we had a lab and used it. Maybe I would then be more interested too" (S51). "If the subjects are made concrete, we can enjoy it. It will not be good when we just read something. Chemistry can be understood by experiments" (S20). "Experiments can make the lesson more interesting in a laboratory environment, where students can participate in the lesson more actively" (S436).

According to the students' comments above, they mentioned practical activities and the laboratory as methods for making chemistry fun and said they could concretize the subjects in this way.

Considering both the quantitative and qualitative findings, whether the students found chemistry fun had a relationship with their interest in chemistry. Moreover, the factors that made the students find chemistry fun were the teacher of the course and the concrete relationship between the chemistry course content and real life. On the other hand, the students who did not find the chemistry course enjoyable said this situation was due to the intensive curriculum, time-related problems, the content of the chemistry lesson, especially the mathematical content, the way the chemistry lesson was taught, the classroom environment, and the lack of practical activities and laboratory environment.

3.1.3 Effect of Teacher on Chemistry Lessons

The students who talked about the importance of the teacher in learning chemistry stated that the chemistry lessons both increased their interest in the lesson and constituted a big factor in making the lesson fun.

S54, who said that one of the factors making the chemistry course fun was the teacher of the course, expressed their thoughts as follows: "It is the teacher who makes the chemistry class the most fun. If the teacher makes the lesson fun and interesting, the lesson will be great" (S54).

The student who stated that the teacher was a factor in liking the chemistry lessons, even though they did not like it, reported their views as follows: "The chemistry course is not fun, but our teacher is very entertaining" (S417). "I didn't like chemistry, but I'm interested in chemistry because I like the teacher" (S17).

Commenting on the teacher's effective teaching of the chemistry course, the students stated that their teacher was energetic and entertaining during the lessons and made jokes, which made the lessons fun. "The teacher should not bore the students" (S51). "It's actually very fun, at least for me, and our lessons are very good. Our teacher does his best for us to understand. We even make jokes for a minute or two so that we don't get bored" (S64). "Adding humor to the subjects while teaching helps us understand the subjects that we would normally not understand" (S26). "Our teacher should be a little more active in the lesson, be nicer to the students, and make a joke or two every once in a while" (S27). "I like teachers who are energetic, crazy, and funny" (S348).

From the thoughts above, the students mentioned the importance of a positive and energetic environment in class. It could be concluded that the teacher can provide this positive atmosphere by not boring the students (without force), by providing a more comfortable environment, and by making them laugh. In this way, a more active environment will be provided.

3.1.4 Importance of Mathematical Skills in Chemistry

The results of the quantitative analyses revealed that 62% (n = 285) of the students stated that mathematical skills had an influence on considering the chemistry course difficult, and it was found that in this respect, there was no significant difference between the male and female students ($p = 0.716$).

Moreover, in response to the question about the effect of mathematical operations in chemistry, 64.5% (n = 214) of the students who stated that they had difficulty in chemistry lessons said they had difficulties in terms of mathematical operations, while 28.6% (n = 99) stated that mathematical operations had no effect.

Stating that the mathematical aspect of chemistry was an important factor in learning chemistry, the students expressed their thoughts as follows: "I have had difficulties in chemistry classes. I cannot cope with the mathematical side of this course because I don't like it. People cannot understand things they don't like" (S347). "In chemistry class, I have difficulty depending on the subject. If our chemistry is good, and if we can do operations related to mathematics, we will do the operations in chemistry as well" (S34).

Based on the views of the above students it can be stated that the mathematical side of chemistry makes chemistry difficult. Students have difficulty learning some subjects, and mathematical operations have a negative effect on students' attitudes toward chemistry.

Among the students who said that their mathematical skills had an effect on learning chemistry, 52% (n = 150) said they liked solving problems, while 37% (n = 107) did not like solving problems. S345 and S425, who said they liked to solve problems, reported their views as follows: "Yes, I like to solve problems because I like doing mathematical operations and because numbers interest me" (S345). "I enjoy solving questions about a subject when I fully understand it in chemistry, but I do not want to solve any problems about a subject that I do not understand" (S425).

S345 and S425 stated that they liked problem solving because of mathematical operations and that they enjoyed it. When S345's view, "I like doing mathematical operations, and numbers interest me," is taken into account, it could be stated that the student associated problem solving more with mathematical operations rather than real life problems.

In addition, some students reported that mathematical operations were important in chemistry lessons and stated that they could not solve problems and did not like chemistry:

> I'm not good at math, anyway. I have difficulties in chemistry because I have difficulties in mathematical operations; that's why, I don't like solving problems in chemistry, but sometimes, when I succeed, I like chemistry. Of course, it doesn't take long (S44).
>
> "My math skills are weak. I become more unsuccessful when mathematical operations are included in my chemistry class. I start disliking the lesson because I can't solve the problems" (S62).

Students who stated that they could not solve problems due to their insufficient mathematical skills believed that this situation had a negative effect on their attitudes toward the lessons: "I stay away from the lesson because I can't solve problems" and "I don't like solving problems either, but sometimes I like chemistry when I succeed, of course it doesn't last long (S2)."

S24, S430, and S45 stated that they found chemistry difficult, but this did not result from the lack of mathematical operations but rather from the chemistry itself.

> Yes, I find chemistry difficult; for example, although I like equations, I can't solve them, especially the concept of moles, which is very challenging for me. The effect of mathematical operations is secondary because, in order to understand mathematical operations, we need to understand what the question is telling us. That's why it's hard for me to understand in terms of chemicals (S430).

"Sometimes, I have difficulties, especially in places that require memorization, because my memorization is not good. There is no sin in mathematics because chemistry is very complicated" (S24). "Mathematics is not difficult, but there are formulas in chemistry that are difficult and confusing" (S45).

The students stated that chemistry was not easy to understand; they reported that it was a complex course with difficult formulas requiring memorization.

3.1.5 Effect of Chemistry on Other Courses

When asked about the effect of chemistry on other courses, 52% of the students (n = 240) stated that it had an impact on other courses, while 36% (n = 167) stated that chemistry did not have a positive effect. When this question was analyzed in terms of gender, it was found that there was no significant difference between the male and female students ($p = 0.303$).

The students who stated that chemistry affected other courses like physics, mathematics, and biology believed that chemistry influenced mathematical courses more, saying, "I find the chemistry course positive. It helps me in physics and mathematics because formulas are in every lesson" (S12). "Yes, it increases my ability to deal with mathematical operations, and it has an effect on mathematical lessons" (S431). "Yes, it has an effect because I love chemistry. I want to be good at physics, biology, and mathematics, and I am doing it" (S43). "Yes, it is effective. It also has an effect on biology; subjects similar to the ones in chemistry also exist in biology" (S17). "In biology and physics lessons, I can use what I learned in chemistry class" (S414).

The students who stated that chemistry had an effect on other non-mathematical courses explained this situation as follows: “Yes, it has an effect; for example, let me give an example of fossil fuels. It also has an effect on geography” (S21). “Considering that all courses are in interaction with one another, of course, it has an effect” (S438). “It is a must for chemistry because all the lessons are in a chain; it has an effect” (S245).

The students who talked about the positive effects of chemistry on other courses attributed this to the fact that chemistry was a mathematical course and that it included subjects similar to mathematical courses. In addition, some chemistry subjects have a positive effect on mathematical courses and that all courses interact, which means that chemistry also indirectly affects them.

The students who stated that chemistry had no effect on other courses by referring to its content expressed their thoughts as follows: “Chemistry does not affect other courses because it is a completely abstract course for me” (S28). “It has no effect, as it is not related to other courses” (S27). “It’s not in my area of interest, so it doesn’t affect other courses at all” (S34).

As seen in the comments above, the students who thought that chemistry did not have a positive effect on other courses think so because they considered chemistry to be abstract and similar to other courses.

Students who thought that chemistry had an effect on other courses generally considered this in terms of the topics covered in chemistry. chemistry is a mathematical course and that some topics in chemistry are similar to the topics covered in physics and biology, resulting in the conclusion that chemistry has a positive effect on these courses. In addition, based on the students’ thoughts that chemistry did not have a positive effect on other courses, the content of chemistry is different from that of other courses and that chemistry is more abstract than other courses. Therefore, it is not similar to other courses and does not have a positive effect.

3.2 The Importance of Chemistry in Students’ Daily and Future Lives

Via the open-ended questions forms, the students were asked questions about the importance of chemistry in their daily and future lives.

3.2.1 The Place of Chemistry in Students’ Career Plans

When the students were asked whether it was possible to choose a profession related to chemistry in their future career plans, a significant difference was found between the male and female students, as the p value (0.038, $p < 0.05$) was in favor of male students. This situation can be seen more clearly in Table 2.

Table 2. Effect of gender on the permanency of chemistry knowledge

Gender		yes	No	Total
Girls	Count	56_b	171_a	259
	% within gender	21.6%	66.0%	100.0%
Boys				
	Count	26_b	134_a	199
	% within gender	13.1%	67.3%	100.0%
Chi-square tests	Value	df	Asymptotic significance (2-sided)	
	8,441	3	0.0038	

According to Table 2, 66% of the female students (n = 171) and 67% of the male students (n = 134) reported that chemistry was not among their preferences for their future career plans.

When the students were asked whether they would have a preference for chemistry in their future careers, 85% (n = 133) of the students who were not interested in chemistry stated that they would not choose chemistry in their future careers.

According to the results of the qualitative analyses conducted, the reason that the female students did not consider chemistry while choosing their future profession was related to the content of the chemistry course. In relation to this question, their responses were as follows:

> I don’t have a preference for chemistry because I don’t understand anything when I listen to the lesson, and I don’t understand when I study the chemistry subject myself. A person not familiar with the content of the lesson cannot be successful in that course (S434).

“No, I don’t prefer it because I am not good at mathematical subjects. I have difficulty in chemistry because I find mathematical operations difficult, and I cannot solve mathematical problems” (S44). “It is not among my

preferences because I don't like it" (S418). "No, because I can't do it. Some parts of the chemistry course have mathematical content" (S9).

In addition, S7 stated that the chemistry course would impact her career, and she related this to the fact that chemistry is a science suitable for doing research. She explained her thoughts about this situation as follows: "Yes, I prefer it because I like doing research a lot" (S7).

Other female students talked about their positive attitudes toward chemistry and stated that they could choose chemistry because it was related to the profession they would choose. "I love chemistry, I imagine myself as an engineer" (S43). "Yes, I can choose it because my goal is to attend a medicine faculty, and chemistry knowledge is necessary in the field of medicine. I would like it to take a place in my career" (S218).

Considering the objections of the female students, it could be concluded that the students who wanted chemistry to be a part of their future careers had a positive attitude toward chemistry and science.

Similarly, male students reported that chemistry could be a part of their future careers, and they related this situation to the profession they would choose as well as to their attitudes toward chemistry. "Yes, because I want to be a scientist in the future" (S28). "I choose chemistry because the profession I will choose is related more to mathematics" (S26). "The professions I want require chemistry. I have to do it" (S428). "Since I am thinking of becoming a doctor in the future, I believe that the courses in physics, chemistry, biology, and mathematics will help me" (S64). "I would prefer it because I want to be a doctor" (S24). "I want to be a civil engineer, so it may be useful for my future" (S422). "I would like to study chemistry, science, or medicine because I want to do the things I love" (S12). "No, I'm interested in culture and history, so I can't choose it" (S351).

Considering the views of the male students, they may choose mathematical departments in their future careers, and chemistry might therefore be included in their future careers. Another group of students reported that chemistry could be part of their future careers because of their positive attitudes toward chemistry and because they liked to work in the fields of science and mathematics. On the contrary, the students who stated that chemistry would not be part of their future careers associated this situation with their career choices.

The students who were aware of the importance of their mathematical skills in the chemistry course also stated that chemistry was scientifically important and that they might choose chemistry in their future careers.

> It is scientifically important; of course, we learn what the main source of matter is and how it is formed. For example, without chemistry, we would not be able to learn what an atom is or what it is like (S433).
>
> "I find it very useful from a scientific point of view because it works for us in every moment of our life, and it is more useful than other branches of science" (S45).

As a result of the quantitative analyses, most of the students (approximately 69%; n = 197) who thought that mathematical operations had an effect on learning chemistry stated that they would not choose a profession related to chemistry in their future careers. The students reported their views about this as follows: "No, while choosing my career, I do not want to consider things that I cannot achieve" (S62). "I don't have any future plans involving it because I can't do it, I don't know anything about chemistry, I don't even want to try to do it, either" (S347). "I don't want to prefer chemistry because over time, I started not to like chemistry anymore" (S440). "No, it's not possible because I don't want to have a profession related to this course" (S56). "No, I can't do it because it is a mathematical course" (S9).

As seen in the views of the students, they stated that they did not have any plans involving chemistry in their future careers because they found the mathematical problems in chemistry difficult. In this case, the quality and importance that mathematics education students receive in the early stages of their academic careers can be developed based on their needs.

3.2.2 Chemistry in a Student's After-School Life

In relation to the responses of the students to the question, "Do you think that chemistry knowledge will be permanent in your life after school? Why?", a significant difference was found between the male and female students. As a result of the quantitative analysis (chi-square test analysis), the p value was 0.009 (< 0.05). The results can be seen in Table 3 below.

Table 3. Effect of gender on the permanency of chemistry knowledge

Gender		Yes	No	total
Girls	Count	173_b	68_a	259
	% within gender	66.8%	26.3%	100.0%
Boys				
	Count	104_b	70_a	199
	% within gender	52.3%	35.2%	100.0%
Chi-square tests	Value	Df	Asymptotic significance (2-sided)	
	11,514	3	0.009	

As can be seen in Table 3, 66.8% of the female students (n = 173) and 52% of the male students (n = 104) reported that chemistry knowledge would be permanent in their future lives.

As a result of the quantitative analysis, it was revealed that chemistry would be permanent in the after-school lives of 217 students (75.6%) who were interested in chemistry. In addition, 58% (n = 91) of those who had no interest in chemistry reported that chemistry would not be permanent in their after-school lives. The students who stated that chemistry would be permanent in their after-school lives often emphasized that this situation stemmed from the close relationship of chemistry with daily life, while some students emphasized that it would be because of the way the teacher taught, and some because of their own efforts. Emphasizing his/her attitude toward chemistry, S429 said, “I think chemistry knowledge will be permanent because I love chemistry, and people do not forget the lessons they love.”

S414 and S345 associated the permanence of chemistry with real life and explained his/her thoughts as follows: “Chemistry becomes permanent in our life after school because it gives us a lot of information about our lives” (S414). “It is permanent because most of the topics we cover are encountered in many places in our daily lives. Thus, the topics become stronger and permanent” (S345).

Saying that the teacher’s effort is effective in keeping chemistry in mind, S21 reported his/her thoughts as follows: “Yes, my teacher explains it so well that it is impossible not to remember it because we do learn based on memorization” (S21).

In addition, S56 stated that the permanence of chemistry resulted from his/her own efforts, saying, “It is permanent because I repeat it and solve the question” (S56).

the permanence of their chemistry knowledge depended on their interest in the lessons and their interest in chemistry in real life. Therefore, they thought this knowledge would be permanent, as they came across chemistry in all areas of their lives.

Furthermore, S28 and S6, who thought that their chemistry knowledge would not be permanent, stated that chemistry was taught based on memorization at school: “I don’t think it will be permanent because memorizing, going home and doing the experiment that was taught or done in the class myself, I do not have the opportunity to rehearse it” (S28). “I’m not so sure it will be better if we learn by seeing, not by writing, and if the information will be more permanent. It’s not permanent because we don’t do any experiments” (S6).

Some of the students who stated that chemistry course was not memorable pointed out that the permanence of chemistry was possible by saying: “for chemistry to be permamnent in every field, one must have an interest in chemistry” (S25). “No because I do not plan to nhave an interest in chemistry in my future life, so chemistry will not be a permanent course for me” (S424)

The students thought the permanence of their chemistry knowledge resulted from the way chemistry was taught in school, and their interest was not great enough. In addition, the students learned chemistry based on memorization, which had a negative effect on the permanence of their chemistry knowledge. They did not have the chance to concretize their chemistry knowledge because there was no laboratory environment in which they could apply their knowledge practically, which caused their chemistry knowledge not to be permanent.

3.2.3 Keeping Up to Date with the Developments in Chemistry

When the students were asked whether they were aware of developments related to chemistry, most of the students (68%, n = 314) stated that they were not aware of developments in chemistry. When this situation was examined in terms of gender, it was found that there was no difference between male and female students (p = 0.493).

Stating that s/he was not aware of the developments in chemistry, S347 explained this situation as follows: “I am not aware of this because it does not interest me at all. I don’t do research, and I don’t listen to the lessons at all”

(S347).

Another student, S437, reported that s/he was unaware of any developments in chemistry, except for the chemistry questions in the national exam conducted for university placement: "We are not aware of any developments related to chemistry. I only rehearse chemistry soon after classes and study for the national university placement exam" (S437).

Based on the student's view above, S437 actually gave important information about the university placement exam system. the chemistry questions asked in the exam were not good enough to allow students to follow and be aware of the developments related to chemistry.

Contrary to this situation, most of the students who stated that they were aware of the developments in chemistry believed that it was important for their daily lives: "At home, my mother's work becomes easier thanks to the chemicals used in washing the dishes" (S28). "Useful for knowing the structure of newly produced drugs, detergents, and perfumes" (S13). "It helps with how we can store our food for a long time" (S350).

According to the students' views above, the students followed the developments in chemistry only as long as they affected their daily lives. In addition, they emphasized the importance of being informed about how chemistry facilitated their daily lives.

4. Discussion

The opinions of the students were gathered under themes of the factors affecting the learning of chemistry and the importance of chemistry in the student's daily and future lives. Under these headings, the chemistry perceptions of the students depended on their interest in chemistry, mathematical skills, problem-solving skills, the role of the teacher, the effect of chemistry on other courses, whether they chose a profession related to chemistry in the future, whether they used their knowledge about chemistry in daily life, and whether they were aware of developments in the field of chemistry.

4.1 The Effect of Success and Gender on Interest in Chemistry

When the students' levels of interest in the chemistry lessons were analyzed, it was seen that being successful, the permanence of the knowledge gained at school, the attitude toward chemistry, and the choice of profession related to chemistry in the future came to the fore. In terms of interest, the success of the participants affected other areas positively. It is possible to say that a successful student may think that the knowledge gained at school is permanent. However, a successful student generally has a positive attitude toward chemstry lessons (Kan & Akbaş, 2006). Interest and success have a dynamic relationship that affect each other mutually (Essien et al., 2015; Nja et al., 2020). Learning becomes easier for students whose interest in the course is aroused (Aina & Adedo, 2013). Parallel to this, Hançer, Uludağ and Yılmaz (2007) stated that there was a positive relationship between the attitudes of the participants toward chemistry and their success in chemistry. Similarly, Bozdağ (2019) reported that attitude had a positive effect on success. According to the finding of positive relationship between interest and career choice, it is not surprising that a student who is successful in a course makes a career choice in that field.

In the literature, Altan, Üçüncüoğlu, and Zileli (2019) found that eighth grade students' interest in courses in this field had an effect on their science, technology, engineering and mathematics (STEM) career choices. However, in the study, it was revealed that the students who found the chemistry lessons enjoyable were more interested in chemistry courses. This result was not surprising because a student who has fun in a lesson is expected to attend that lesson enthusiastically, be willing to take the lesson, and have an interest in the course (Boyraz & Serin, 2015). Based on student-centered practices in learning environments, the purpose is to make lessons fun for students and to help them demonstrate positive behaviors and attitudes toward the lessons. One of the positive results obtained in the study was that the participants found the chemistry course enjoyable and that their interest was affected by this. However, when we looked at the forms delivered from the students, a significant portion of the students stated that they were not satisfied with the way the chemistry lesson was taught and with the lack of laboratories and content, and that they did not find the lesson enjoyable. Studies have revealed that the science laboratory infrastructure is insufficient in secondary education institutions in Turkey (Baran, 2016). In this respect, chemistry lessons could be made more enjoyable by teachers, and student-centered practices could increase students' interest in this course. With traditional teaching methods, chemistry becomes more boring and students' success decreases as a result. Therefore, it is important to investigate how to make learning environments more enjoyable (Kavak & Köseoğlu, 2007). At this point, it is possible to say that student-centered practices are effective (Baran, 2011). So, for more entertaining chemistry lessons, it is absolutely necessary to develop the school infrastructure and create environments such as chemistry laboratories. According to Cüceloğlu (2005), motivation is characterized as "a general concept that includes wishes, desires, needs,

impulses and interests". Yıldız- Yalçın and Özdemir (2021) found a significant relationship between positive perception and motivation in their study. As students' interest increases, their positive perceptions of chemistry lessons will also improve.

Another result of the study was that there was no significant difference between the male and female students' interest in the chemistry course and their levels of enjoyment of the course. This result was thought to be positive in terms of the effect of gender on interest in STEM fields. This result gives hope that the career choices of women in the field of chemistry might increase. Interest of female students in STEM fields, including chemistry, is lower than that of male students. Glory and Sopuruchi (2015) found that male students were more interested than female students when they examined the effect of gender on interest in integrated science education. Similarly, Temitope (2011) found that women were more interested in the arts than in science. On the other hand, Baran (2016) revealed that students' interest in a physics course did not change depending on gender. Because courses in chemistry and physics are under the same roof, this finding is consistent with the findings obtained in the present study.

4.2 Teacher's Effect on Interest in Chemistry

The teacher's effect was striking regarding factors affecting learning. Teachers are among the most important components of learning environments, just like students. Teachers have a great influence on students. Students are generally interested in the lessons of teachers they like, listen to, respect, and have as role models. In addition, the methods and techniques used by the teacher while teaching the lesson can also ensure that the students have an interest in and positive attitude toward the lessons. This situation was quite clear in the students' opinions in this study. Igwe (2017) pointed out that teachers' in-class behaviors and practices positively affect students' interests, success, and attitudes toward chemistry courses. Gardner (2005) stated that students' attitude towards learning chemistry played a vital role in maximizing learning and motivating them to learn that subject with better performance.

4.3 Effect of Mathematical Skills on Interest in Chemistry

As a result of the quantitative analysis, most of the students stated that mathematical skills made the chemistry course difficult, and there was no significant difference between male and female students. The causes of this finding can be understood when the students' opinions are examined. The students stated that they did not like mathematics, problem solving, and formulas. However, mathematics is an important and necessary part of chemistry. The self-confidence and problem-solving skills that students will have in the field of mathematics will cause chemistry lessons to be understood more easily (Akinoso, Oladimeji, & Taiwo, 2016); For effective chemistry education, students must have sufficient background knowledge of mathematics (Levitus, 2022; Towns & Rodriguez, 2019). If chemistry lessons are not only given with formulas in learning environments but are taught based on learning-by-doing, students will not perceive chemistry as just being made up of formulas but will see it as a part of daily life. In this way, students will not only understand that chemistry is applicable to many areas of their daily lives but also develop a perception that it is not just about formulas.

4.4 Effect of Chemistry on Other Courses

One of the important topics that emerged on the basis of perceptions of chemistry is the students' views about whether chemistry has an effect on other courses. When the responses to this question were analyzed in terms of the variable of gender, it was found that there was no significant difference between the male and female students. Based on most of the students' views about this situation, the positive situation in the chemistry course reflected positively upon the courses in physics, mathematics, and biology. The students might have thought that these courses were connected to one another. According to the STEM approach, science and mathematics are naturally in a relationship with each other under the title of science. It was not surprising in this respect that the students thought these areas affected each other positively. On the other hand, when the views of the students who claimed chemistry did not have an effect were examined, these students did not like the chemistry lessons; they found the chemistry lessons abstract, and they were therefore unsuccessful.

4.5 Profession Preference in Chemistry and Permanence

One of the important findings obtained in the study was how the students use chemistry in their daily and future lives Some of the students had a negative attitude toward choosing a profession regarding chemistry in the future. A significant majority of both female and male students stated that they did not plan a career involving chemistry in the future. However, it was revealed that there were significant differences between male and female students. According to the data obtained via the open-ended question forms from the students, the students pointed out that they were not interested in the chemistry lessons and that they did not understand the lessons, especially the

mathematical operations. Within the context of these results, it is thought that the mathematics education given in the school environment is important and that the improvement of mathematics education can pave the way for career choices in other mathematical fields, such as chemistry. Mathematics self-confidence can be improved in students with qualified mathematics education. Blotnicky, Franz-Odendaal, French and Joy (2018) stated that Students with high mathematics self-efficacy have more information about STEM careers including chemstry and prefer these careers more. Another important finding obtained in the study was that, according to most of the students, the knowledge they gained in the chemistry course would be permanent. This finding was greater among female students. The female students were more optimistic about this issue. This finding is considered important because the literature indicates that female students report more negative opinions about science fields, such as chemistry (Baran, 2016). They thought the permanence of their chemistry knowledge depended on their interest in the course and the relationship between chemistry and real life. In addition, the students thought that this knowledge would be permanent, as they came across chemistry in all areas of life. For this reason, it is not difficult to estimate how the teaching effectiveness of chemistry as a part of daily life in learning environments will impact students' perceptions. Orgill and Bodner (2004) stated that it was not desirable to teach chemistry only through chemical symbols, formulas, equations, definitions, and theories without establishing a connection between chemistry and daily life. When students are able to associate science concepts with their daily lives, their motivation and interest in chemistry lessons increase (Kiyici & Aydoğdu, 2011; Osborne et al., 2003). According to the students, the permanence of their chemistry knowledge stemmed from the way chemistry was taught at school, and their low interest. The students learned chemistry via memorization, which had a negative effect on the permanence of their chemistry knowledge. They were unable to concretize chemistry, as there was no laboratory environment in which they could apply their knowledge practically, which caused their chemistry knowledge to be impermanent.

4.6 Keeping up to Date with the Latest Developments in Chemistry

Most of the students stated that they were not aware of developments in chemistry. When this situation was examined in terms of the variable of gender, there was no difference between male and female students. The students were not interested in chemistry, and they studied their lessons in an exam-oriented manner. The university placement exam is of vital importance for students because after taking this exam, they will enter a process that will affect their future careers. Baş and Kivilcim (2019, p. 652) stated that students have a high level of anxiety during this process. They analyzed the effect of university placement exams on students in a study they conducted with high school students using metaphors. In the study, the students found this exam to be "a worrying, disturbing, and torturing concept," "an unfair/unnecessary race," "a concept whose outcome is unclear, which we encounter in many places, and which is endless, variable, or always present," "a turning point which requires effort and hard work," "a concept determining our lives," and "a long-term or short-term race." In this respect, the similar result obtained in this study was not surprising.

4.7 Conclusion

In light of the findings obtained in the present study, the following suggestions can be taken into account:

- It would be beneficial to get students' opinions about the content and application of chemistry courses in learning environments.
- It is beneficial to use student-centered applications to make chemistry lessons fun in the learning process.
- In order to conduct chemistry lessons more effectively, chemistry teachers must be well equipped. It will be useful to review the education provided in education faculties.
- The physical infrastructures of schools, such as science laboratories, should be improved to conduct chemistry lessons more effectively.
- Besides the Ministry of National Education, teachers and parents have important duties to reduce the negative effects of anxiety about university placement exams.
- Replicating this study with other grades will enrich the literature.

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