Online Science Education Journal *http://dergipark.gov.tr/ofed*

2025; 10(2): 53 - 77.

Difficulties of Students in Learning High School Physics Courses and Suggestions for Solutions[1]

Yağmur Üral*, *Erzincan Binali Yıldırım University*
Paşa Yalçın, *Erzincan Binali Yıldırım University*

*Corresponding Author: yagmur.ural@erzincan.edu.tr

To cite this article: Üral, Y., & Yalçın, P. (2025). Difficulties of students in learning high school physics courses and suggestions for solutions. *Online Science Education Journal, 10*(2), 53-77.

Article Info

Article History

Received:
03 March 2025

Accepted:
19 June 2025

Keywords

Physics course
Difficulties in high school physics course
Opinion of high school physics students

Abstract

The study aimed to examine the attitudes of 12th grade students with different demographic characteristics (gender, school type, and achievement level) towards physics lessons, the topics and concepts they found difficult in this lesson, the reasons for these difficulties, and their suggestions for solutions to these difficulties. Conducted using a descriptive qualitative research design, the data were collected using an unstructured questionnaire. Qualitative data and demographic information were collected using an unstructured 'questionnaire to determine students' views on difficult topics and physics' prepared by the researchers. The validity of the questionnaire was ensured by expert opinions, while its reliability was tested through a pilot application. Ninety-six high school physics students studying in a small province in Eastern Anatolia participated in the study. The collected data were analysed using content analysis. As a result of the analyses, the topics that students found challenging in their 12th-grade high school physics course and the solutions to these challenges were determined based on the students' opinions. The topic of electricity and magnetism was identified as the most challenging. The students' responses regarding why they found this topic challenging were presented under themes such as 'difficult to understand, abstract, etc.,' while their proposed solutions were presented under themes such as 'lightening the curriculum, making it more concrete, etc.'

INTRODUCTION

The education system aims to provide individuals with basic knowledge and skills in different fields. In this context, the education process extends from pre-school education to higher education (Rizaldi et al., 2022). There are many subjects within the education system, one of which is science. The specific objectives of the science course, as determined by the Ministry of National Education, include providing students with basic knowledge and skills in areas such as biology, physics, chemistry, science and engineering applications, astronomy, and environmental sciences (Ministry of National Education, 2018a). Physics, biology, and chemistry are among the priority areas that aim to provide basic knowledge in science courses.

[1] This study is derived from the master's thesis titled "Determining the topics that students have difficulty in high school physics teaching and suggestions for solutions". It was also presented as an oral presentation at the 40th International Physics Congress of the Turkish Physics Association.

These disciplines play an important role in explaining many events and phenomena encountered in daily life.

Physics is a scientific discipline that studies the general properties of matter beyond its chemical structure through experiments, observations, and applications; it mathematically expresses these properties based on general or temporary laws. Due to its role in laying the foundation for the development of complex technologies, physics plays a critical role in a country's technological advancement (Mahmudah et al., 2022). Physics also plays an important role in explaining the working principles of events encountered in daily life and the technological tools used. Understanding many phenomena, from motor vehicles to mobile phones, from lightning to aeroplanes, is possible through physics education (Şahin & Yağbasan, 2012). Therefore, it is of great importance that students have a good understanding of physics concepts. Individuals who have a good grasp of physics can interpret and explain natural phenomena more accurately. Physics continues to be one of the fundamental areas encountered throughout the educational life of students, especially those interested in the positive sciences. In this context, it is expected that physics concepts will be thoroughly understood so that they can be used effectively in line with scientific thinking and technological development.

Physics, which is covered as part of science education at primary school level, is one of the fundamental subjects that students encounter alongside biology and chemistry. At primary school level, physics topics are generally limited to basic and compulsory content (Rizaldi & Fatimah, 2024). According to the same study, physics is covered more comprehensively as a separate subject at the secondary school level, and students are more aware of the learning requirements in this field.

Throughout the educational process, students may encounter various challenges (Byukusenge et al., 2022; Bello et al., 2018; Kyado et al., 2021; Onowugbeda, 2020). These challenges may arise in both teaching and learning processes. According to Sigron and colleagues (2025), difficulty can be defined as the individual's need to learn unusual ways of thinking and behaving in new areas of knowledge in order to overcome obstacles. One of the common difficulties encountered is that students describe some subjects as ‘difficult’ during their education. Science subjects, which have low success rates in national and international exam results, are among the subjects that students struggle with the most, starting from primary school (Tuncel & Fidan, 2018). Among science courses, physics in particular is seen as one of the most challenging areas by students (Bahar & Polat, 2007; Ogunkola & Samuel, 2011; Timur et al., 2016). In addition, physics stands out as one of the least favourite courses among students (Mahmudah et al., 2022). Rizaldi and Fatimah (2024) found that approximately 62% of students did not enjoy learning physics. Angell et al. (2004) revealed that some students found physics lessons boring and irrelevant. Ornek and colleagues (2008) noted that many students find physics difficult and openly express this view. Considering that students' perceptions of the subject directly influence their learning processes, the belief that ‘physics is difficult’ can be said to be a determining factor in student success (Harwanto, 2019). Physics is seen as a difficult subject, especially for average students, and achieving success becomes difficult when sufficient time and effort are not invested (Sobel, 2009; Harwanto, 2019).

There are many reasons why students find physics difficult. According to Harwanto (2019), the lack of references in textbooks and insufficient practical activities also make physics learning difficult. In addition, students' insufficient mathematical background and abstract learning materials are among the factors that cause students to struggle with physics (Rizaldi et al., 2021).

In subjects that students find challenging, some subtopics create more difficulty than others. Ogunkola and Samuel (2011) stated that the difficulties students experience in certain topics in science subjects directly affect the teaching of the subject. When evaluated specifically in physics, it is seen that students struggle not only in general but also in certain topics. Rizaldi and Fatimah (2024) found that waves and optics are among the most difficult topics for students to learn. In a study conducted by Üral and Yalçın (2024), high school physics teachers concluded that students struggle most with electricity and magnetism. Antonowiski and colleagues (2017) noted that the abstract nature of modern physics makes it difficult for students to understand. Lasry et al. (2009) argued that physics education is incomplete without a sufficient mathematical foundation. In line with these findings, Harwanto (2019) stated that students having to process different representational forms (experiments, formulas, calculations, graphs, conceptual explanations) simultaneously in physics class makes the learning process even more complex.

It is known that such difficulties negatively affect students' motivation and attitudes towards physics lessons (Akdeniz et al., 2000; Bahar & Polat, 2007). Therefore, it is important to identify the topics that students find challenging in physics and to develop solutions to these problems. The fact that physics can be applied in many areas of life makes it necessary to teach this subject in an efficient and effective manner. There are many studies on this subject in the literature, and these studies address the topics that students find difficult in physics, the reasons for these difficulties, and solution proposals from different perspectives (Bahar & Polat, 2007; Ernisho, 2013; Ogunkola & Samuel, 2011; Ornek et al., 2008; Şahin & Yağbasan, 2012; Tuncel & Fidan, 2018). The data obtained from these studies reveal that factors such as the abstract nature of the subject, the high level of mathematical knowledge required, individual differences, and teaching methods contribute to the difficulties encountered in physics education.

Identifying the concepts and topics that students find challenging in physics education, understanding the reasons for these difficulties, and developing solutions has been a subject of research for a long time (Akdeniz et al., 2000; Bahar & Polat, 2007; Harwanto, 2019; Rizaldi & Fatimah, 2024; Üral & Yalçın, 2024). As mentioned above, studies conducted since the early 2000s have provided important data on this subject. However, the rapid changes in educational programmes, teaching methods, and technological tools today necessitate the updating of these findings.

In this context, it is necessary not only to identify the topics that students find difficult in physics lessons, but also to understand their perceptions of these difficulties and evaluate the proposed solutions from the students' perspective. Despite studies conducted in different years and with different samples, questions such as whether students still struggle with similar topics, whether their perceptions of these difficulties have changed, and how their proposed solutions have changed remain relevant. Therefore, studies based on current student opinions will provide meaningful contributions to the literature in terms of both revealing the current situation and comparing it with past findings.

This study aims to examine the attitudes of 12th grade students with different demographic characteristics towards physics lessons, the topics they find difficult, the reasons for these difficulties, and suggestions for solutions in light of qualitative data. In-depth analyses conducted specifically on the ‘Electricity and Magnetism’ unit, which is highlighted as a problematic area in the literature, will contribute to the development of more effective and student-centred strategies in teaching this subject.

Nowadays, laboratory applications, simulation-based learning methods, and active learning strategies are becoming increasingly widespread. This study is expected to guide teachers and researchers not only by describing the current situation but also by contributing to the process of developing educational solutions, as it includes students' views and expectations regarding such innovative applications.

The Purpose of Study

The aim of this study is to determine the attitudes of 12th grade students with different demographic characteristics towards physics lessons, the topics and concepts they find difficult in this lesson, the reasons for these difficulties, and suggestions for solutions to these difficulties. Additionally, in-depth analyses will be conducted on the 'Electricity and Magnetism' unit, which is among the topics students find most challenging, to identify the causes of learning difficulties in this area and propose detailed solutions. To achieve these objectives, the following research questions have been addressed;

1. How do 12th grade students' attitudes towards physics lessons, their success rankings and motivation differ according to demographic variables?
2. What are the most challenging topics for 12th grade students in physics class, and how do these topics vary according to demographic variables?
3. What are the reasons for the difficulties experienced by students who report struggling with physics class?
4. How do students assess the effects of the physics topics they find challenging on their attitudes and motivation?
5. What are the students' suggestions for improving their performance in physics class?
6. What types of difficulties do students experience, particularly in the area of electricity and magnetism, and what types of solutions do they propose for these difficulties?

METHOD

Study Design

Descriptive qualitative research design was used in the study. Descriptive qualitative research is a research design that aims to reveal the views, experiences and perceptions of individuals about a particular subject (Merriam, 2009). The main reason for choosing this research design is to describe the current situation directly in line with the participants' statements by detailing the difficulties experienced by the students in the physics course. Descriptive qualitative research is widely preferred in the field of educational sciences because it enables an existing phenomenon or situation to be revealed directly through the narratives of the participants (Sandelowski, 2000). In addition, structuring the research questions with open-ended questions and following a data collection process based on the views of the participants in qualitative research is seen as an approach appropriate to the nature of the research (Creswell, 2013). In this study, a questionnaire consisting of unstructured open-ended questions was applied to determine the thoughts of senior high school students about the physics course and their suggestions for solutions about the subjects they had difficulty with. In qualitative research, collecting data directly from the statements of the participants and analysing these statements in a systematic way allows in-depth examination of the research findings (Patton, 2002). In this context, descriptive qualitative research design was preferred as it is an appropriate approach to understand the difficulties experienced by students in physics course and to evaluate their solution suggestions.

Study Group

The sample of this study consists of 12th grade students attending four different types of high schools (Anatolian, Science, Project, and Social Sciences) in a small province in the Eastern Anatolia Region. A total of 96 students participated in the study. Fifty-one of the participants were female, and 45 were male. 35 students attend Anatolian high schools, 30 attend science high schools, 16 attend project schools, and 15 attend social sciences high schools.

The reason for selecting 12th grade students for the sample group is that these students have covered most of the topics in their physics courses and will cover the remaining topics during the same period. The participants' achievement levels were determined based on their academic performance as evaluated by their teachers. Thirty students described themselves as successful, 37 as average, and 29 as low achievers.

Data Collection

The data were collected by means of an unstructured questionnaire developed by the researchers to determine students' views on physics course and difficult topics. The questionnaire consisted of two parts. In the first part of the questionnaire, demographic characteristics of the students were tried to be determined. The demographic characteristics to be determined were the gender of the students, their achievement status and the type of high school they attended. In the second part of the questionnaire, 12 open-ended questions were used to determine the students' views on physics and the subjects with difficulties and their suggestions for solutions. For the validity of the questionnaire, three experts in the field of physics education were consulted. After the final version of the questionnaire was prepared in line with the expert opinions, a pilot application was carried out with 15 students who were not from the sample in order to test the reliability of the questionnaire. The results of the pilot application were re-evaluated by the researchers and physics educators and necessary changes were made. The survey was administered to 12th grade students attending four different types of high schools (Anadolu, Science, Project, and Social Sciences). These types of high schools cater to different fields. Anadolu high schools provide general academic education. Science high schools are geared toward students who are talented in science and mathematics. Social sciences high schools cater to students who excel in social fields such as literature, history, and geography. Project high schools are high-quality schools selected by the Ministry of National Education that offer special programs and advanced opportunities to students with high academic achievement. A total of 96 students from these types of high schools participated in the study.The students to whom the questionnaire was applied were considered in three different cases (low, average and successful) with different achievement levels. In determining which students would participate in the data collection, the opinions of the teachers of the relevant courses regarding the students' performance were taken into consideration. No written documentation was collected during the student selection process. The individuals recommended by the teachers were included in the study on a voluntary basis.

Data Anaysis

Content analysis method was used to analyse the data collected after the application of the questionnaire in accordance with the purpose of the research. Content analysis is an analysis method that enables qualitative data to be systematically classified, interpreted and interpreted (Elo & Kyngäs, 2008). This method aims to reveal and interpret hidden meanings by collecting the data obtained from the participants under certain categories (Hsieh & Shannon, 2005). By adopting an inductive approach in the study, the data were coded and categorised in line with the students' views. Firstly, the data were categorised according to demographic characteristics, then the answers given to the open-ended questions were carefully read and the repetitive

expressions and meaningful patterns in the data set were identified. Then, the codes were analysed and themes were formed by combining the statements with similar contents. Finally, the themes obtained were compared in terms of different demographic groups and descriptive interpretations were made.

Validity and Reliability

The data collection tool used in the study was developed by the researchers and the opinions of three academicians who are experts in the field of physics education were consulted to ensure content validity. In line with the expert opinions, necessary arrangements were made in the questionnaire questions and it was structured in a way to allow the students to express their opinions about the physics course and the subjects they had difficulty in. In order to increase the reliability of the data collection tool, a pilot study was conducted with 15 students who were excluded from the sample before the actual application and necessary revisions were made in line with the feedback obtained as a result of this application. In addition, students from different high school types were included in the sample in order to provide data triangulation. Thus, it was aimed to obtain a more comprehensive perspective by increasing the diversity of opinions. In order to ensure the internal validity of the research, direct quotations from the participants were included and the data were supported by the participants' statements. In order to minimise researcher bias, coding was done with another researcher during the data coding process. In order to ensure external validity, the method of the research was explained in detail and a clear road map was presented for researchers who will conduct similar studies. Thus, both internal and external reliability of the research were supported and the scientific validity of the findings was increased. In line with these measures, it was aimed to increase the validity and reliability of the research and to put the findings on a more solid basis.

FINDINGS

The findings were obtained from the analysis of data collected through a survey designed to determine students' opinions on challenging topics and physics. The findings are presented under six subheadings for the purpose of correlating the research questions with the survey questions. Table 1 shows which research question is related to which survey question. Some survey questions were examined in the context of different demographic characteristics. Three different demographic characteristics were considered in this examination. The two demographic characteristics asked in the survey were gender and school type. The third demographic characteristic was the level of achievement, which was learned verbally from the students' teachers before the survey, rather than from the students themselves. For gender, two options were provided: female and male. For school type, four options were provided: Anatolian, Social Sciences, Science, and Project. For achievement level, three options were provided: low, medium, and successful. Some of the findings were analysed based on these options.

Table 1. Research question and related survey items

Research question	Relevant survey item no
1. How do 12th grade students' attitudes towards physics lessons, their academic performance and motivation differ according to demographic variables?	1, 2, 4 and 5
2. What are the most challenging topics for 12th grade students in physics class, and how do these topics vary according to demographic variables?	8 and 10
3. What are the reasons for the difficulties experienced by students who say they struggle with physics?	3 and 8
4. How do students assess the effects of challenging physics topics on their attitudes and motivation?	4 and 5

5.	What are your suggestions for helping students succeed in physics class?	6, 7 and 9
6.	What kinds of difficulties do students encounter, particularly in the field of electricity and magnetism, and what kinds of solutions do they propose to address these difficulties?	10, 11 and 12

First Research Question

The first question addressed in the study was, 'How do 12th grade students' attitudes towards physics, their academic performance, and their motivation differ according to demographic variables?' Four questions related to this research question were included in the survey. These questions are questions 1, 2, 4, and 5. The findings of these questions are presented below.

First survey question

The first question in the survey asked students, 'Do you like physics class?' The results of the analysis of the data for the first question are presented in Figure 1 in terms of different demographic characteristics. As seen in Figure 1, 27 students said they did not like physics, 15 said they liked physics to some extent, and 54 said they liked physics. These answers are examined separately for demographic characteristics below.

As shown in Figure 1, when comparing by gender, it can be seen that of the 15 students who partially like physics, 8 are female and 7 are male, while of the 54 students who like physics, 26 are female and 28 are male. Of the 27 students who do not like physics, 17 are female and 10 are male.

As shown in Figure 1, in the comparison made according to school type, 9 of the 15 students who partially liked physics were from Anatolian high schools, 2 were from social sciences high schools, 1 was from a science high school, and 3 were from project high schools. Of the 54 students who liked physics, 19 were from Anatolian high schools, 3 were from social sciences high schools, 23 were from science high schools, and 9 were from project high schools. Among the 27 students who did not like physics, 7 were from Anatolian high schools, 10 were from social sciences high schools, 6 were from science high schools, and 4 were from project high schools.

As shown in Figure 1, in the comparison based on success level, 4 of the 15 students who partially liked physics were successful, 7 were moderately successful, and 4 were unsuccessful. Among the 54 students who liked physics, 20 were successful, 18 were moderately successful, and 16 were unsuccessful. Among the 27 students who did not like physics, 6 were successful, 12 were moderately successful, and 9 were unsuccessful.

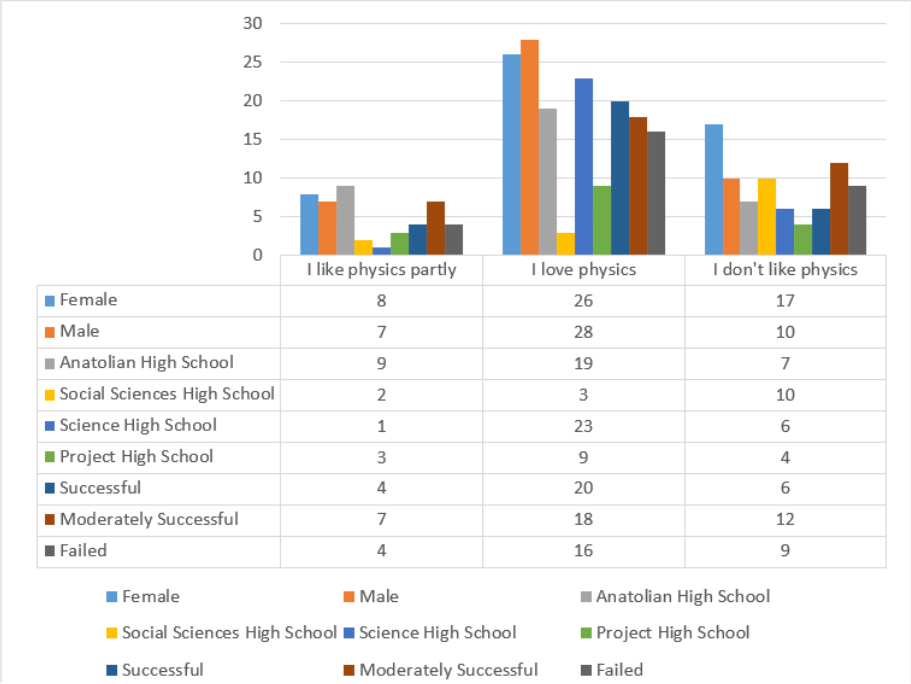


Figure 1. Comparison of the answers to the first question between demographic groups

Second survey question

As the second question of the survey, students were asked, 'When you compare your success in physics with your success in other subjects, where does physics rank among the top 10 subjects?' The analysis results of the data for the second question are presented in Table 2 below in the form of a frequency table. The frequencies were examined separately in writing outside of the table in terms of different demographic characteristics. These answers are examined separately for demographic characteristics below.

As shown in Table 2, students ranked their success in physics classes in the top 10 according to their own assessments, placing it in 3rd, 4th, and 2nd place, respectively. The responses of students who ranked physics 3rd, 4th, and 2nd were compared according to demographic groups.

When comparing students who ranked physics 3rd in the top 10 by gender, 11 were female students and 11 were male students. When compared by school type, 10 were Anatolian school students, 8 were science school students, and 4 were project high school students. When compared by achievement level, 9 were high achievers, 8 were average achievers, and 5 were low achievers.

When comparing students who ranked 4th in the top 10 in physics by gender, 10 were female students and 6 were male students. When comparing by school type, 8 were Anatolian high school students, 5 were science high school students, and 3 were project high school students. When compared by achievement level, 7 were successful, 5 were moderately successful, and 4 were unsuccessful students.

When comparing students who ranked 2nd in physics among the top 10 by gender, 4 were female students and 9 were male students. When compared by school type, 4 were Anatolian high school students, 7 were science high school students, and 2 were project high school students. When compared by academic performance, 4 were high achievers, 5 were average achievers, and 4 were low achievers.

Table 2. Table of answers to the second question

Physics ranking in the top 10	Frequency(f)
1st place	5
2nd place	13
3rd place	22
4th place	16
5th place	7
6th place	3
7th place	7
8th place	8
9th place	7
10th place	8

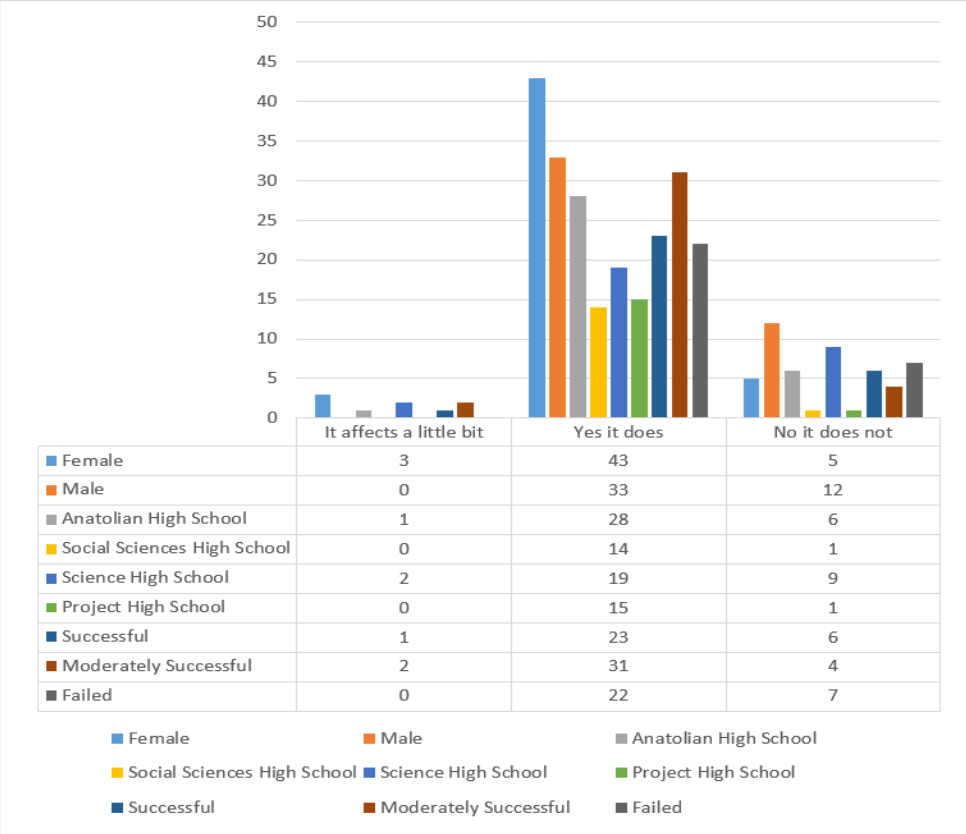
Fourth survey question

The fourth question in the survey asked students, 'Do the topics you find difficult in physics affect your motivation to study physics?' The results of the analysis of the data for the fourth question are presented in Figure 2 within the framework of different demographic characteristics. As seen in Figure 2, 17 students stated that the topics they found difficult in physics did not affect their motivation for physics, 3 students stated that it affected them slightly, and 76 students stated that it affected them. Most of the students who stated that the topics they found difficult in physics affected their motivation towards physics indicated that this effect was negative. In other words, they stated that it had a demotivating effect. These answers are examined separately for demographic characteristics below.

As seen in Figure 2, in the comparison by gender, it is seen that 43 of the 76 students who stated that the topics they found difficult in physics affected their motivation towards physics were female and 33 were male, while 5 of the 17 students who stated that it did not affect them were female and 12 were male, and all of those who stated that it affected them partially were female students.

As shown in Figure 2, in the comparison made according to school type, 28 of the 76 students who stated that the topics they found difficult in physics affected their motivation towards physics were from Anatolian high schools, 14 were from social sciences high schools, 19 were from science high schools, and 15 were from project high schools. Of the 17 students who stated that it did not affect their motivation, 6 were from Anatolian high schools, 1 was from a social sciences high school, 9 were from Science High Schools, and 1 was from a Project High School. Among the 3 students who stated that it partially affected their motivation, 1 was from an Anatolian High School and 2 were from Science High Schools.

As seen in Figure 2, in the comparison made according to achievement level, among the 76 students who stated that the topics they found difficult in physics affected their motivation towards physics, 23 were successful, 31 were moderately successful, and 22 were unsuccessful. Among the 17 students who stated that it did not affect them, 6 were successful, 4 were moderately successful, and 7 were unsuccessful. Among the 3 students who stated that it partially affected them, 1 was successful and 2 were moderately successful.



	It affects a little bit	Yes it does	No it does not
Female	3	43	5
Male	0	33	12
Anatolian High School	1	28	6
Social Sciences High School	0	14	1
Science High School	2	19	9
Project High School	0	15	1
Successful	1	23	6
Moderately Successful	2	31	4
Failed	0	22	7

Figure 2. Comparison of the responses to the fourth question between demographic groups

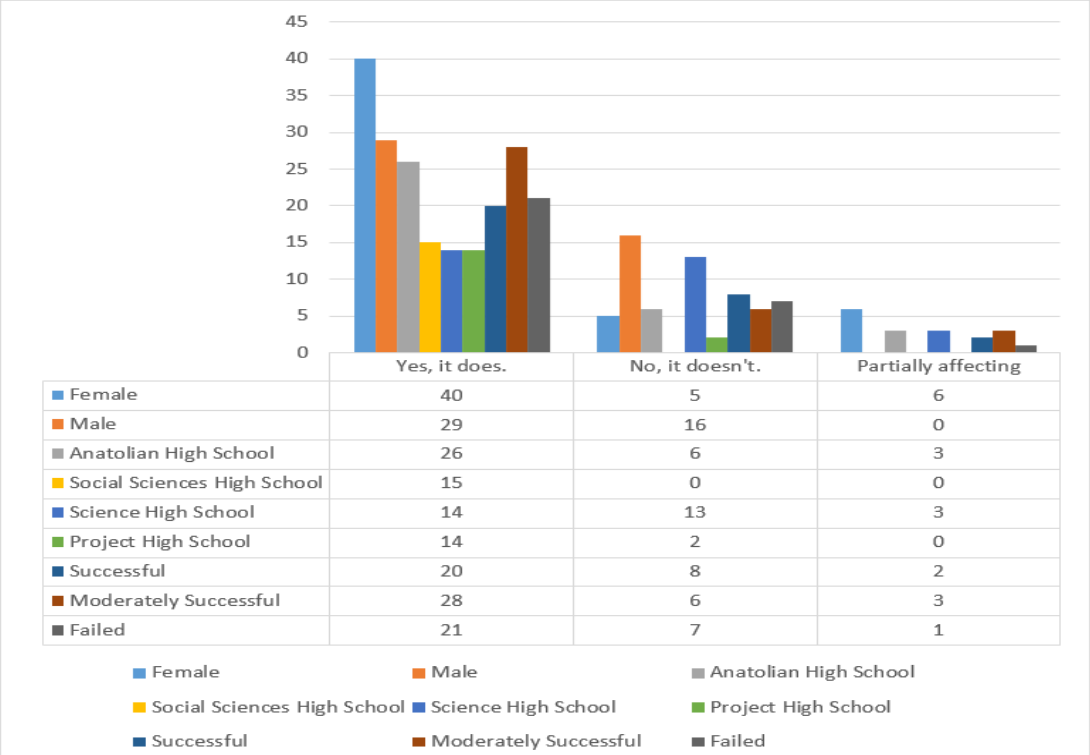
Fifth survey question

The fifth question in the survey asked students, 'Do the topics you find difficult in physics affect your attitude towards physics?' The analysis of the data for the fifth question is presented in Figure 3 in terms of different demographic characteristics. As seen in Figure 3, 21 students stated that the topics they found difficult in physics did not affect their attitude towards physics, 6 students stated that it affected them partially, and 69 students stated that it affected them. Most of the students who stated that the topics they found difficult in physics affected their attitude towards physics stated that this effect was negative. These answers are examined separately for demographic characteristics below.

As shown in Figure 3, in the comparison by gender, it was observed that 40 of the 69 students who stated that the topics they found difficult in physics affected their attitude towards physics were female and 29 were male, while 5 of the 21 students who stated that it did not affect their attitude were female and 16 were male, and all of those who stated that it partially affected their attitude were female students.

As seen in Figure 3, in the comparison made according to school type, 26 of the 69 students who stated that the topics they found difficult in physics affected their attitude towards physics were Anatolian high school students, 15 were social sciences high school students, 14 were science high school students, and 14 were project high school students. Of the 21 students who stated that it did not affect their attitude, 6 were Anatolian high school students, 13 were from science high schools, and 2 were from project high schools. Among the 6 students who stated that it partially affected their attitude, 3 were from Anatolian high schools and 3 were from science high schools.

As shown in Figure 3, in the comparison made according to achievement level, among the 69 students who stated that the topics they found difficult in physics affected their attitude towards physics, 20 were successful, 28 were moderately successful, and 21 were unsuccessful. Among the 21 students who stated that it did not affect them, 8 were successful, 6 were moderately successful, and 7 were unsuccessful. Among the 6 students who stated that it partially affected them, 2 were successful, 3 were moderately successful, and 1 was unsuccessful.



	Yes, it does.	No, it doesn't.	Partially affecting
Female	40	5	6
Male	29	16	0
Anatolian High School	26	6	3
Social Sciences High School	15	0	0
Science High School	14	13	3
Project High School	14	2	0
Successful	20	8	2
Moderately Successful	28	6	3
Failed	21	7	1

Figure 3. Comparison of the responses to the fifth question between demographic groups

Second Research Question

Secondly, the study sought to answer the question, 'What are the most challenging topics for 12th grade students in physics class, and how do these topics differ according to demographic variables?' Two items were included in the survey related to this research question. These questions are questions 8 and 10. The findings of these questions are presented below.

Eighth survey question

The eighth question in the survey asked students, 'Which of the physics topics covered in grades 9, 10, 11, and 12 do you find most challenging? Please explain why.' The results of the analysis of the data from the eighth question are presented in Table 3. As shown in Table 3, the top three topics that students found most challenging were Electricity and Magnetism, Optics, and Waves, in that order.

Table 3. Physics topics that high school 9th, 10th, 11th and 12th grade students have difficulty in

Challenged Topics	Frequency(f)
Introduction to Atomic Physics and Radioactivity	10
Pressure and Lifting Force	18
Simple Harmonic Motion	13
Circular Motion	10

Wave Mechanics	8
Waves	22
Electricity and Magnetism	41
Electrostatic	15
Energy	7
Introduction to Physics	3
Motion and Force	11
Heat and Temperature	7
Force and Motion	15
Matter and Properties	3
Applications of Modern Physics in Technology	8
Modern Physics	12
Optics	40

By coding the answers to Question 8, themes were created regarding the reasons for the difficulties experienced in the most challenging topics in physics lessons. These themes are shown in Figures 4, 5 and 6.

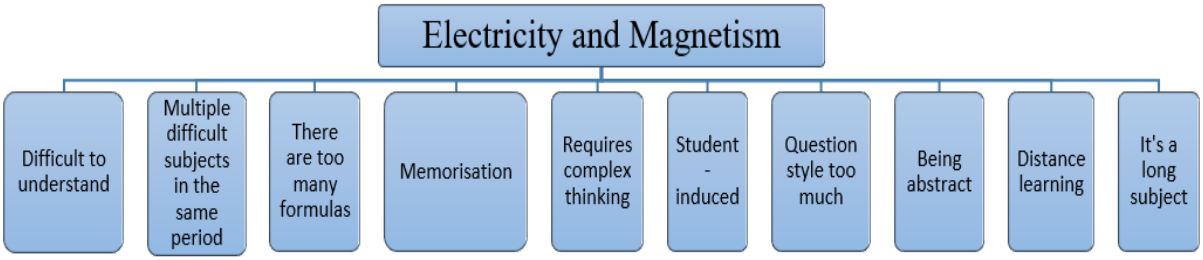


Figure 4. Themes related to the reasons for students' difficulties in electricity and magnetism

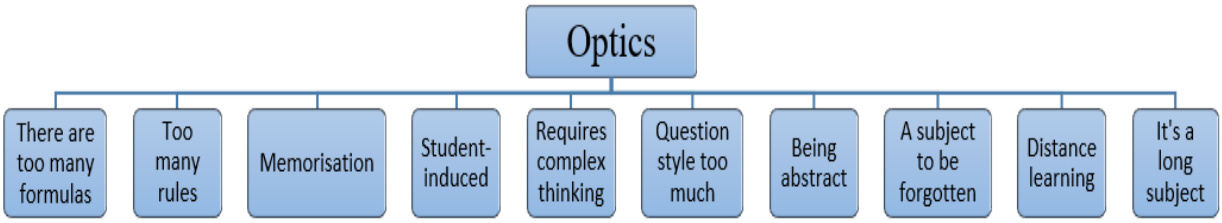


Figure 5. Themes related to the reasons for students' difficulties in optics

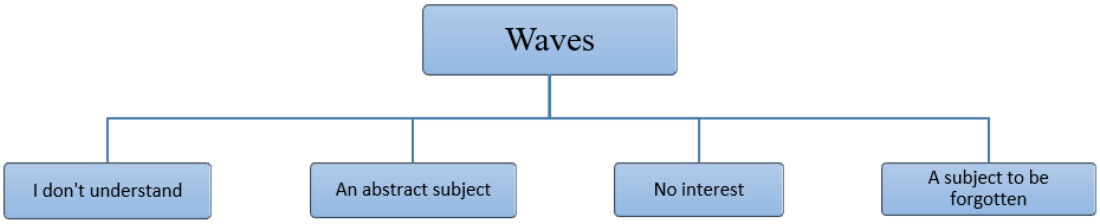
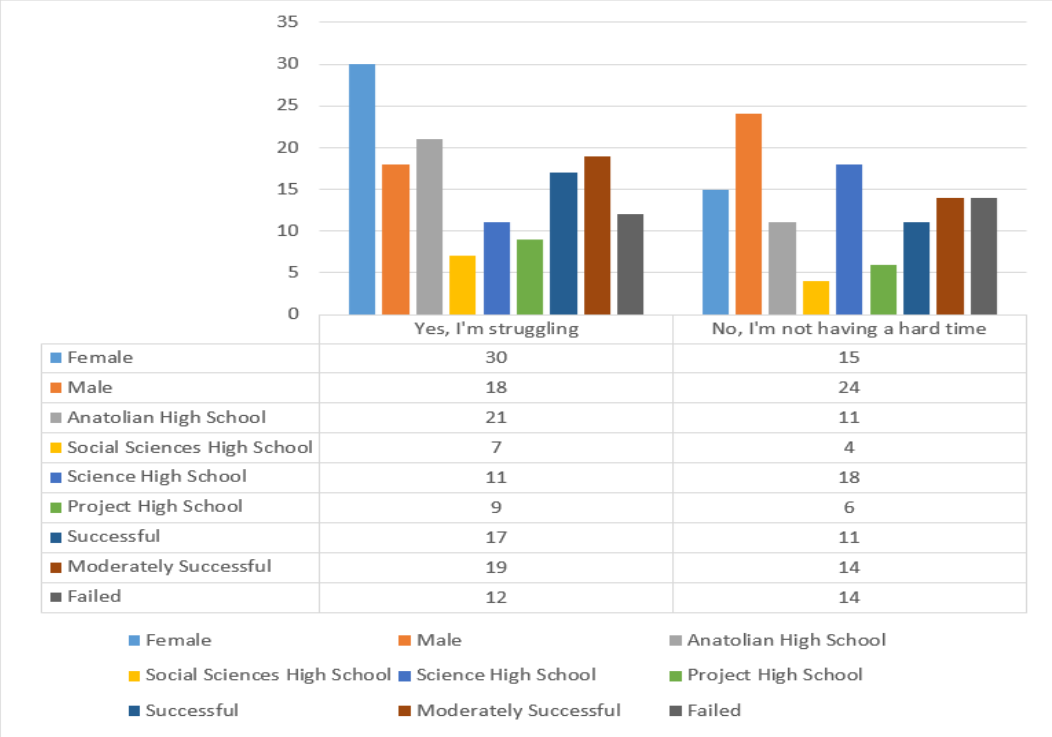


Figure 6. Themes related to the reasons for students' difficulties in the subject of waves

Tenth survey question

As the eighth question of the survey, students were asked, "According to a survey conducted among high school physics teachers, the topic that students find most difficult in high school physics is Electricity and Magnetism. Do you think this is the most difficult topic in high school physics? Please explain why." The analysis results for the tenth question are presented in Figure 7. As seen in Figure 7, 48 students reported experiencing difficulty with

electricity and magnetism, which was identified as challenging by high school physics teachers according to Üral and Yalçın (2024), while 39 students reported not experiencing any difficulty.



	Yes, I'm struggling	No, I'm not having a hard time
Female	30	15
Male	18	24
Anatolian High School	21	11
Social Sciences High School	7	4
Science High School	11	18
Project High School	9	6
Successful	17	11
Moderately Successful	19	14
Failed	12	14

Figure 7. Comparison of the answers to the tenth question between demographic groups

As shown in Figure 7, in the comparison made according to gender, it was seen that 30 of the 48 students who said they had difficulty in electricity and magnetism were female and 18 were male, while 15 of the 39 students who said they did not have difficulty in electricity and magnetism were female and 24 were male.
As seen in Figure 7, in the comparison made according to school type, it was observed that 21 of the 48 students who said they had difficulty with electricity and magnetism were Anatolian high school students, 7 were social sciences high school students, 11 were science high school students, and 9 were project high school students, while 11 of the 39 students who said they did not have difficulty with electricity and magnetism were Anatolian high school students, 4 were from social sciences, 18 were from science, and 6 were from project high schools.

As seen in Figure 7, in the comparison made according to achievement level, 17 of the 48 students who said they had difficulty with electricity and magnetism were successful, 19 were moderately successful, and 12 were unsuccessful, while among the 39 students who reported not struggling with electricity and magnetism, 11 were successful, 14 were moderately successful, and 14 were unsuccessful.

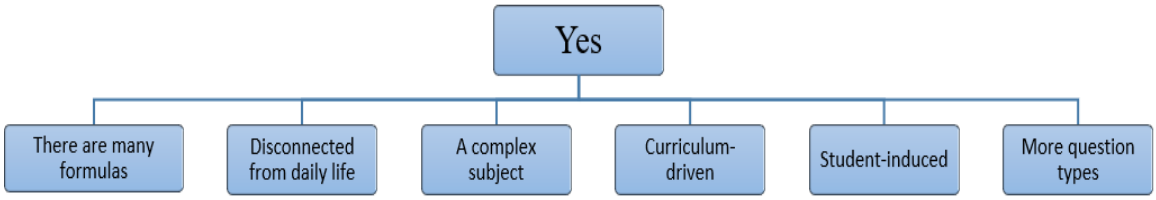


Figure 8. Themes formed for those who answered ‘yes’ to the tenth question

Students who stated that electricity and magnetism were the most difficult topics in high school physics classes also explained why they found them difficult. The themes created after coding the answers are presented in Figure 8. The answers of some students who stated that they found electricity and magnetism difficult in question 10 are presented below.

S22 *"...There are too many formulas, which is confusing..."*
S16 *"...We don't use what we learn in our daily lives very much..."*
S77 *"...It's too long and confusing..."*
S45 *"...Because the 11th grade curriculum is too heavy..."*
S27 *"...The subject doesn't interest me..."*
S95 *"...There are too many types of questions..."*

Third Research Question

Thirdly, the study sought to answer the question, 'What are the reasons for the difficulties experienced by students who report struggling with physics?' Two items were included in the survey related to this research question. These questions are questions 3 and 8. The findings of these questions are presented below.

Third survey question

The third question in the survey asked students, 'Do you find physics difficult? Could you explain why you find it difficult?' The analysis results for the third question are presented in Figure 9. Of the 96 students who participated in the survey, 63 indicated that they struggled with physics, 19 indicated that they did not struggle, and 14 indicated that they struggled somewhat.

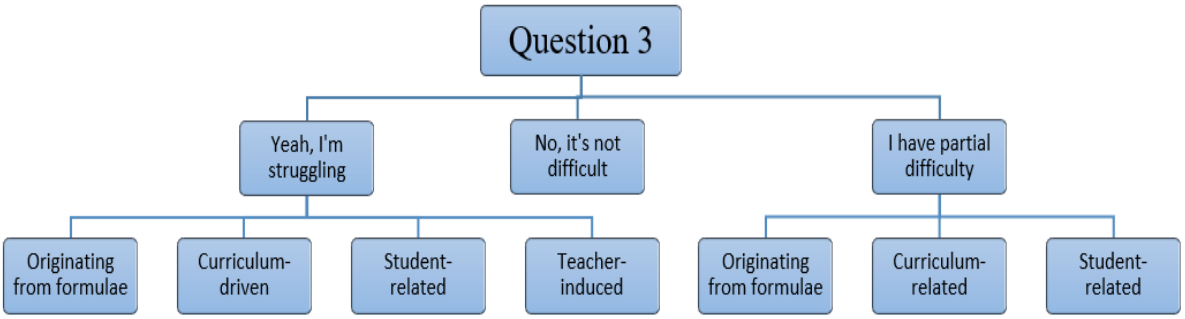


Figure 9. Themes created for the third question

The difficulties reported by students who stated that they struggled or somewhat struggled with the physics course were coded. At the end of the coding process, four main themes emerged from the responses of students who indicated difficulty in physics, as shown in Figure 9. These themes were identified as reasons related to formulas, curriculum, students, and teachers.

Below are some responses from students whose difficulties in physics were attributed to "formula-related" reasons.

S1 *"... Due to the large number of formulas, I sometimes forget them. ..."*
S94 *"... I have difficulty applying the formulas to the problems. ..."*

Some responses from students who attributed their difficulties in physics class to curriculum-related reasons are presented below.

S15 *"... The curriculum is challenging. ..."*
S42 *"... The curriculum is heavy. ..."*

Some student responses indicating teacher-related reasons for difficulties in the physics course are presented below.

S7 *"... I struggle because the topics are taught very superficially…"*

S91 *"... Generally, since teachers cannot effectively convey the information, we fail to understand the lessons…"*

Some responses from students indicating that the cause of their difficulties in physics lessons is "student-related" are presented below.

S21 *"... I struggle because I do not put enough effort …"*

S45 *"... I have difficulties due to gaps in my understanding of the topics …"*

The reasons for partial difficulties experienced by students in physics lessons were coded and categorized into three themes, as illustrated in Figure 9: formula-related reasons, curriculum-related reasons, and student-related reasons.

Some responses from students who reported that their partial difficulties in physics lessons were "formula-related" are presented below.

S68 *"... Formulas are challenging …"*

S90 *"... There are too many formulas in some topics …"*

Some responses from students who indicated that their partial difficulties in physics lessons were "curriculum-related" are presented below.

S67 *"... The topics are difficult. More precisely, the topics within the curriculum are challenging. ..."*

Some student responses indicating that their difficulties in the physics course were "student-related" are presented below.

S27 *"... Because it does not interest me much, I do not study extensively. ..."*

The data related to the eighth survey question, which addresses this research question, are presented in Table 3 and Figures 4, 5, and 6. Below are the responses provided by some students regarding the reasons for difficulties in the top three topics they identified as the most challenging.

S6 *"…Topics that require memorization…"*

S9 *"…Being an abstract subject…"*

S24 *"…These topics contain many formulas and require complex thinking…"*

S31 *"…It is difficult to relate to everyday life…"*

Fourth Research Question

The fourth research question of the study aimed to investigate: "How do students evaluate the impact of the physics topics they struggle with on their attitude and motivation?" Two items related to this question were included in the survey, namely items 4 and 5. The majority of students responded to the fourth item by stating that the physics topics they find difficult negatively affect their motivation. The findings related to this response are presented in Figure 2 and were examined in detail under the first research question. Similarly, most students answered the fifth item by indicating that the challenging physics topics negatively influence their attitudes. The findings for this response are shown in Figure 3 and were also analyzed thoroughly under the first research question.

Below are some student responses indicating that the difficult physics topics negatively impacted their motivation, as expressed in the fourth survey item.

S66 *"...My morale is greatly affected..."*
S45 *"... It reduces my love for the course and lowers my motivation..."*

Some students' responses indicating that the physics topics they struggle with negatively affect their attitudes, as stated in the fourth survey question, are presented below.

S74 *"...When I can't do it, I distance myself from physics class..."*
S51 *"...I become disinterested in the course..."*

Fifth Research Question

In this study, the fifth research question aimed to explore, "What are students' suggestions for improving their success in physics lessons?" Three items in the survey corresponded to this question—items 6, 7, and 9. The findings related to these questions are presented below.

Survey Item Six

In the sixth item of the survey, students were asked, "Does teaching physics through activities or laboratory work affect your academic achievement?" As shown in Table 4, 11 students indicated that teaching physics with activities or laboratory sessions did not affect their academic achievement, 4 students were undecided, and 81 students stated that it had an effect. These students reported that the effect was positive.

Table 4. Table of answers to the sixth question

Student Response	**Frequency(*f*)**
Yes it does	81
No it doesn't	11
Undecided	4

Survey Item Seven

In the seventh item of the survey, students were asked, "Does teaching physics through activities or laboratory work affect your attitude?" As shown in Table 5, 12 students stated that teaching physics with activities or laboratory sessions did not affect their attitude, 2 students were undecided, and 80 students indicated that it did have an effect. These students reported that the effect was positive.

Table 5. Answers to the seventh question

Student Response	**Frequency(*f*)**
Yes it does	80
No it doesn't	12
Undecided	2

Survey Item Nine

In the ninth item of the survey, students were asked, "How would you like the lessons to be conducted in order to better learn the topic(s) you find difficult? Please explain why." The themes regarding how students wish the lessons to be conducted for better understanding of the topics they struggle with are presented in Figure 10.

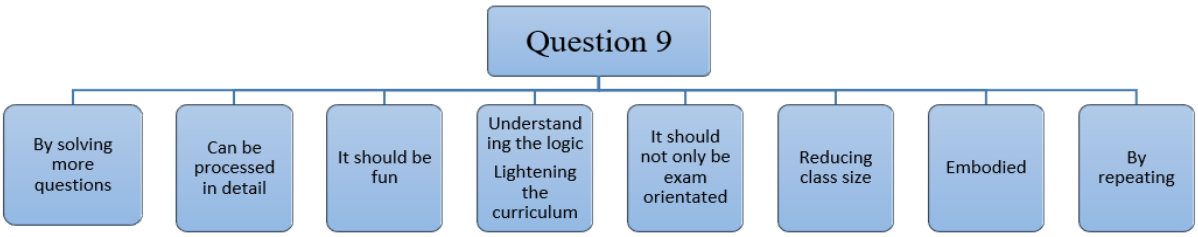


Figure 10. Themes created for the ninth question

Some students' suggestions for better learning of the topics they find difficult, as provided in response to the ninth survey question, are presented below.

S16 *"... Lessons can be taught by showing many types of questions…"*
S39 *"... It should be slow and detailed…"*
S95 *"... I would like it to be taught in a more enjoyable way…"*
S24 *"... If the logic is emphasized, topics can be learned better…"*
S29 *"... The curriculum could be made more flexible…"*
S31 *"... Only exam-focused teaching should be avoided…"*
S2 *"... Based on experiments and observations…"*
S17 *"... Teaching based on practice would help make it more memorable…"*
S38 *"... With simulations…"*
S44 *"... With animations. I think it would contribute to visual memory and mental visualization…"*
S71 *"... More examples from daily life should be given…"*

Sixth Research Question

In the study, the sixth research question aimed to explore "What kinds of difficulties do students experience specifically in the topic of Electricity and Magnetism, and what solutions do they propose to address these difficulties?" Three items in the survey corresponded to this research question—namely, questions 10, 11, and 12. The findings related to these questions are presented below.

Eleventh Survey Item

As the eleventh item of the survey, students were asked: "According to the survey conducted by Üral and Yalçın (2024) among high school physics teachers, Electricity and Magnetism was identified as the most challenging topic for students in high school physics, which includes six subtopics listed below. Which of these subtopics do you find most difficult? Please explain your reason." Table 6 presents the frequency distribution of the subtopics within Electricity and Magnetism where students reported experiencing the most difficulty. According to the frequency data in the table, the subtopics that students found most challenging, in descending order, are transformers, alternating current, magnetism, and electromagnetic induction.

Table 6. Subtopics that high school students have difficulty in electricity and magnetism

Difficult Subtopics	Frequency(f)
Electric Force and Electric Field	20
Electrical Potential	18
Uniform Electric Field and Capacitance	35
Magnetism and Electromagnetic Induction	41
Alternating Current	52
Transformers	53

The themes regarding why students experience difficulties in the subtopics of Electricity and Magnetism listed in Table 4 are presented in Figure 11.

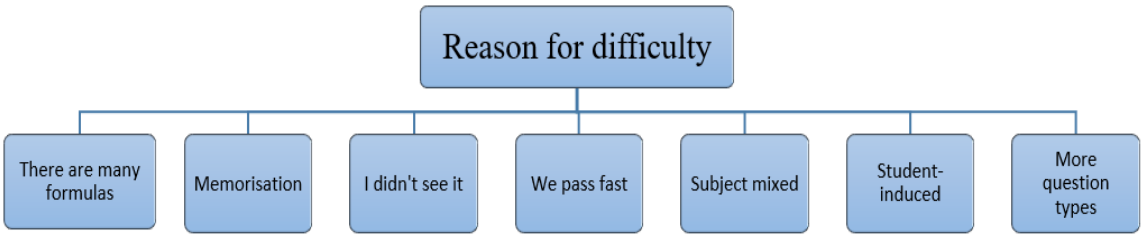


Figure 11. Themes related to the reasons for students' difficulties in subtopics of electricity and magnetism

Some students' responses regarding the reasons for difficulties they experience in the subtopics of Electricity and Magnetism, as asked in the eleventh question, are presented below.

S16 *"...The topic is extremely complex and difficult..."*
S22 *"...There are many similar formulas..."*
S38 *"...There are too many question types that require interpretation..."*
S50 *"...Because I don't see it in detail enough..."*
S78 *"...It is difficult to understand..."*
S94 *"...I can't do it because I think the topic is hard..."*

Twelfth Survey Item

As the twelfth item of the survey, students were asked: "According to the survey conducted by Üral and Yalçın (2024) with 12th-grade physics teachers, the topic that students struggle with the most in high school physics is Electricity and Magnetism. Please write your suggestions on how students' difficulties in this topic can be overcome." Based on the students' suggestions for overcoming difficulties in the most challenging topic, Electricity and Magnetism, twelve themes were identified and are presented in Figure 12.

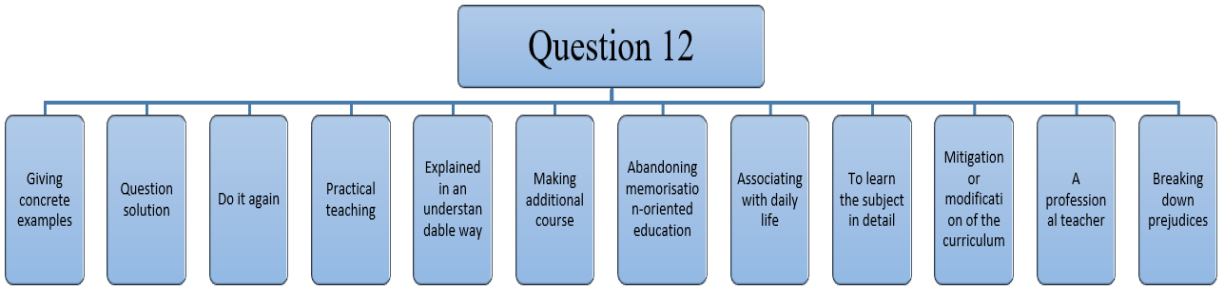


Figure 12. Themes created for the twelfth question

Below are some students' suggestions for overcoming the difficulties experienced in Electricity and Magnetism, as provided in response to the twelfth survey question.

S9 *"...Experiments should be conducted or simulations should be utilized..."*
S20 *"...Activities in physics workshops should be increased..."*
S23 *"...The difficult topics should be somewhat simplified..."*
S60 *"...The topic should be grasped concretely to be better remembered..."*

The word cloud illustrating the frequency of the themes presented in Figure 12 is shown in Figure 13. Since the research was conducted in Turkish, the word cloud representing the theme intensities has been prepared in Turkish.

Figure 13. Suggestions offered by students to overcome the difficulties encountered in Electricity and Magnetism

CONCLUSION, DISCUSSION AND SUGGESTIONS

As a result of the data analysis, the attitudes of 12th-grade students with different demographic characteristics toward physics, the challenging topics and concepts in the course, the underlying causes of these difficulties, and proposed solutions were identified.

The attitudes, achievement rankings, and motivations of 12th-grade students toward physics were examined. According to the analysis, only 28.13% of students reported that they did not like physics. This rate is lower compared to the findings of several previous studies that reported more widespread negative attitudes toward physics (Angell et al., 2004; Mahmudah et al., 2022; Rizaldi & Fatimah, 2024). This discrepancy may be attributed to characteristics of the sample group, the instructional process, or the structure of the measurement tool. An examination of the demographic characteristics of students who stated that they did not like physics revealed that female students slightly outnumbered male students; most were from Social Sciences High Schools and were of moderate academic performance. When students were asked to rank their success in physics relative to other subjects, they most frequently placed physics in the 3rd, 4th, and 2nd positions within their top ten. However, it was observed that students from Social Sciences High Schools never selected these ranks. Demographic analysis showed that among students who placed physics in 3rd position, there was a gender balance, a majority from Anatolian High Schools, and predominantly high-achieving students. The profile of students who ranked physics 4th was similar, although a higher proportion were female. In contrast, among those who ranked physics 2nd, male students and students from Science High Schools were the majority. These findings indicate a close relationship between students' perceived success in physics and their demographic characteristics. High-achieving students tended to rank physics higher in their success rankings, while moderately achieving students mostly placed it lower than fourth. This may be due to the perception of physics as a difficult subject by students with average academic performance. Similar observations have been noted in the literature, highlighting that students of average achievement often perceive physics as a challenging subject (Sobel, 2009; Harwanto, 2019). The tendency of Science High School students and male students to rank their physics success higher suggests that academic orientation and interest toward physics may vary by gender and school type. On the other hand, the fact that Social Sciences High School students did not select high ranks for physics implies a different academic focus and interest profile. It is also noteworthy that despite having a generally high level of academic success, students from Anatolian High Schools demonstrated

a more balanced gender distribution in their perceived success in physics. This emphasizes the importance of considering demographic factors in assessing students' success in physics. Additionally, the majority of students stated that the topics they found difficult in physics negatively affected their motivation and attitudes toward the subject. This finding is consistent with previous research (Akdeniz et al., 2000; Bahar & Polat, 2007). Bahar and Polat (2007) found that students' negative attitudes were related to the topics they struggled with. An analysis of the demographic profiles of students who reported a negative impact on their motivation due to challenging topics revealed a concentration of female students, students from Anatolian High Schools, and moderately achieving students. Similarly, the profile of students whose attitudes were negatively affected closely paralleled those with decreased motivation. These results demonstrate that the challenges encountered in physics have adverse effects on both motivation and attitude. The greater negative impact observed among female and Anatolian High School students is particularly noteworthy. The prominence of moderately achieving students in this group suggests a complex relationship between academic achievement and motivation-attitude dynamics, as students with both low and very high achievement levels appeared to experience this effect less. This indicates that the perception of difficulty in physics varies depending on the student profile and directly influences the learning process. Therefore, it is crucial to design support mechanisms specifically targeting difficult topics by taking students' demographic characteristics into account in order to enhance motivation and attitudes. The perception of low achievement and difficulty in science subjects reported in national and international assessments (Tuncel & Fidan, 2018; Harwanto, 2019) also resonates with the findings of this study in terms of students' attitudes, motivation, and perceived success in physics. Notably, the fact that the majority of students did not report disliking physics suggests a partial divergence from the generally negative attitudes reported in the literature.

The topics that 12th-grade students found most challenging in physics and the variation of these difficulties according to demographic variables were identified. Students particularly reported experiencing difficulties in the areas of electricity and magnetism, optics, and waves. These topics are also recognized as difficult in the literature (Rizaldi & Fatimah, 2024; Şahin & Yağbasan, 2012). Akdeniz et al. (2000) stated that the challenges related to electricity and magnetism begin in elementary school and persist through middle and high school levels. Similarly, in a study conducted by Üral and Yalçın (2024) with physics teachers, electricity and magnetism were reported as among the most difficult physics topics. Students attributed the difficulties in electricity and magnetism to factors such as the abstract nature of the concepts, the difficulty of relating them to everyday life, the abundance of formulas and the need for memorization, the intensity of the curriculum, the variety of question types, and the negative effects of distance education. Difficulties in optics were associated with the excessive number of formulas, reliance on rote learning, the necessity for complex thinking, and the ease with which the content is forgotten. The topic of waves was described with perceptions such as "incomprehensible," "abstract," and "uninteresting." The literature also emphasizes that topics involving mathematical expressions, calculations, abstract concepts, and limited connection to real-life experiences are particularly challenging for students (Harwanto, 2019; Timur et al., 2016).

A total of 65.63% of students reported experiencing difficulties in physics. This finding is consistent with several studies in the literature (Antonowiski et al., 2017). While some research indicates that students face the most challenges in physics among all science subjects, others directly highlight the difficulties encountered specifically in physics classes. The primary causes of these difficulties are attributed to the abstract and complex nature of the subject, as well as factors related to the instructional process. In particular, the large number of complex

formulas, an overloaded curriculum, and abstract concepts contribute significantly to students' struggles. Moreover, teaching methods and materials often fail to adequately address students' needs, negatively impacting their motivation and academic performance. The difficulties become more pronounced in topics that require mathematical operations. Students' inability to study sufficiently or mismatches between their learning preferences and instructional styles also exacerbate these challenges. Additionally, poor teacher-student communication and the way the curriculum is delivered are important factors that adversely affect students' attitudes and motivation toward physics. These findings align with previous research that identifies abstraction, curriculum density, ineffective teaching methods, and communication problems as key obstacles in physics education (Bahar & Polat, 2007; Kakız, 2019; Örnek et al., 2008; Erinosho, 2013; Akdeniz et al., 2000).

An analysis of students' suggestions for improving their success in physics revealed that 84.38% of the participants believed that activity-based or laboratory-supported instruction enhanced their academic achievement. Similarly, 83.33% stated that such practices positively influenced their attitudes toward the physics course. These findings underscore the significant and positive impact of experiential learning environments on both students' performance and attitudes. Students' suggestions were grouped under nine thematic categories: solving more practice problems, providing more detailed instruction, making the lessons more enjoyable, fostering conceptual understanding, reducing curriculum intensity, avoiding exam-centered teaching, decreasing class size, concretizing abstract concepts, and offering more opportunities for review. In particular, the theme of "concretization" is directly aligned with several objectives outlined in the Ministry of National Education's physics curriculum (MoNE, 2018b), which emphasizes the importance of helping students construct meaning through hands-on experiences and real-world connections.

5. Collecting data by performing experiments and obtaining results and generalisations by analysing these data,

6. Comprehend the basic principles, principles and methods of physical science by associating them with events in daily life (MEB, 2018b).

Although students' demand for concretization aligns with curriculum objectives, the findings indicate that this need is not sufficiently addressed in practice. Bahar and Polat (2007), in a study conducted nearly two decades ago, emphasized that the intensity of the curriculum hindered the inclusion of adequate observations, experiments, and activities. Despite the rapid advancements in curricula, instructional methods, and technological tools since then, the persistence of similar issues among students today suggests that the findings of previous research have not been adequately considered in educational planning. This situation makes it more difficult to achieve curriculum goals and introduces additional challenges into the learning process. Consequently, the abstract nature of physics should be supported by concrete learning experiences. Students highlighted that, compared to traditional lecturing, interactive and experience-based instruction has a more positive effect on both achievement and attitude. Particularly in physics courses with high conceptual density, it is essential to consider not only the cognitive but also the affective dimension of learning. In this context, the increased integration of laboratory practices and active learning approaches is critically important for enhancing student success and engagement.

The study identified the specific challenges students faced within the subtopics of the Electricity and Magnetism unit—considered the most difficult topic by high school physics teachers in the study conducted by Üral and Yalçın (2024)—as well as their suggestions for overcoming these difficulties. The subtopics in which students reported the greatest difficulty were transformers,

alternating current, magnetism, and electromagnetic induction. To address these challenges, students emphasized the importance of concrete learning practices such as experiments, simulations, and hands-on physics workshops. They also stated that in order to make learning more comprehensible, it is necessary to overcome preconceived notions, establish connections with daily life, and move away from rote-learning approaches. Similarly, the literature recommends strategies such as breaking down students' misconceptions, using concrete examples, implementing hands-on instructional methods, relating the subject matter to everyday life, and avoiding memorization-based teaching in order to reduce learning difficulties (Bahar & Polat, 2007; Erinosho, 2013; Kakız, 2019; Şahin & Yağbasan, 2012; Timur et al., 2016; Tuncel & Fidan, 2018).

The findings of the study reveal that the topics students struggle with the most in middle and high school physics classes are Electricity and Magnetism, Optics, and Waves. These difficulties stem from several factors, including the abstract nature of the topics, their extensive mathematical content and requirement for formula knowledge, insufficient connection to real-life contexts, the failure to address students' individual learning needs during instruction, and the density of the curriculum. Moreover, the limited variety of teaching methods and techniques, reliance on rote-learning approaches, overcrowded classrooms, and weak student–teacher interaction negatively affect the learning process. As a result, students tend to develop negative attitudes toward physics and experience a decline in motivation. To overcome these challenges, students suggested that lessons should be made more concrete, topics should be linked to everyday life, practical teaching activities should be increased, the content should be simplified, and the instructional process should be made more engaging.

Although laboratory practices, simulation-based learning methods, and active learning strategies are widely used today, it is observed that students' proposed solutions to the topics they find difficult have largely remained unchanged. Since the conduct of studies reported in the literature, no significant changes have been observed in students' suggestions specifically related to Electricity and Magnetism topics. This indicates that students' perspectives have not been sufficiently considered in the instructional solution development process, and the findings from these studies have not been adequately emphasized in practice. In this context, although this issue has been addressed in similar ways previously, the persistence of students' solution proposals over the years highlights the relevance and the need for effective solutions. This study draws renewed attention to problems frequently mentioned in the literature but insufficiently reflected in practice, aiming to offer concrete recommendations for the instructional process, particularly regarding challenging topics such as Electricity and Magnetism.

The findings indicate that the goals of experiential learning and relating topics to daily life in the physics curriculum are not sufficiently addressed in practice, which constitutes a fundamental cause of the difficulties students face in the learning process. In light of these findings, various adjustments are proposed to reduce students' learning challenges in physics. Firstly, teaching methods and techniques that support students in understanding the underlying logic of physics concepts should be encouraged instead of rote memorization and exam-focused approaches. Additionally, the course content should be structured to enable students to relate the topics to everyday life, which will both facilitate learning and help change students' negative attitudes toward the subject. Finally, this study was limited to students from a specific region; conducting research with a larger and more diverse sample would enhance the generalizability of the results.

Ethical Considerations

In this study, all the rules specified in the 'Directive on Scientific Research and Publication Ethics of Higher Education Institutions' were meticulously followed. None of the actions under the second part of the directive, 'Actions Contrary to the Ethics of Scientific Research and Publication', have been carried out.

Table 7. Ethics committee information

Name of the ethical review board	:	Erzincan Binali Yıldırım University Human Research Educational Sciences Ethics Committee
Date of the ethical assessment decision	:	30/12/2022
Number of the ethical assessment certificate	:	12/10

REFERENCES

Akdeniz, A. R., Bektaş, U., & Yiğit, N. (2000). İlköğretim 8. sınıf öğrencilerinin temel fizik kavramlarını anlama düzeyi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 19*(19), 5-14.

Angell, C., Guttersrud, Ø., Henriksen, E. K., & Isnes, A. (2004). Physics: Frightful, but fun. Pupils' and teachers' views of physics and physics teaching. *Science education, 88*(5), 683 706.

Antonowiski, R., Alencar, M. V., & Rocha, L. C. T. (2017). Difficulties to learn and to teach modern physics. *Scientific Electronic Archives, 10*(4), 50-57.

Bahar, M., & Polat, M. (2007). The science topics perceived difficult by pupils at primary 6-8 classes: diagnosing the problems and remedy suggestions. *Educational Sciences: Theory & Practice, 7*(3), 1113-1130.

Bello, T. O., Opaleye, O. S., & Olatunde, A. N. (2018). Perceived difficult concepts in physics among senior secondary school students in Ife central local government area of Osun state. *International Journal of Contemporary Issues in Education, 3*(2), 30-41.

Byukusenge, C., Nsanganwimana, F., & Paulo Tarmo, A. (2023). Difficult topics in the revised biology curriculum for advanced level secondary schools in Rwanda: teachers' perceptions of causes and remedies. *Journal of Biological Education, 57*(5), 1112-1128.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). SAGE Publications.

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107-115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

Erinosho, S. Y. (2013). How do students perceive the difficulty of physics in secondary school? An exploratory study in Nigeria. *International Journal for Cross-Disciplinary Subjects in Education (IJCDSE), 3*(3), 1510-1515.

Harwanto, U. N. (2019). What makes introductory physics difficult. *Jurnal Saintika Unpam: Jurnal Sains dan Matematika Unpam, 2*(1), 28-37.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687

Kakız, B. (2019). *Öğretmen ve öğrenci görüşlerine göre ortaokul fen bilimleri dersinde zorluk çekilen konular ve nedenleri* [Yüksek Lisans Tezi]. Muğla Sıtkı Koçman Üniversitesi.

Kyado, J., Achor, E. E., & Adah, E. (2021). Identification of Difficult Concepts in Chemistry by Some Secondary School Students and Teachers in Nigeria. *Journal of the International Centre for Science, Humanities and Education Research*, *5*(1), 85-98.

Lasry, N., Finkelstein, N., & Mazur, E. (2009). Are most people too dumb for physics. *The physics teacher*, *47*(7), 418-422.

Mahmudah, R. A., Zulirfan, Z., & Rahmad, M. (2022). Analysis of physics learning difficulties in the topic of quantum phenomena of madrasah aliyah students in indragiri hulu. In *Journal of Physics: Conference Series* (Vol. 2309, No. 1, p. 012089). IOP Publishing.

MEB. (2018a). *Fen Bilimleri Dersi (3, 4, 5, 6, 7 ve 8. Sınıflar) Öğretim Programı*. http://mufredat.meb.gov.tr/Programlar.aspx

MEB. (2018b). *Ortaöğretim Fizik Dersi (9,10,11 ve 12. Sınıflar) Öğretim Programı*. http://mufredat.meb.gov.tr/Programlar.aspx

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Ogunkola, B. J., & Samuel, D. (2011). Science teachers' and students' perceived difficult topics in the ıntegrated science curriculum of lower secondary schools in Barbados. *World Journal of Education*, *1*(2), 17-29.

Onowugbeda, F. U. (2020). Variation and genetics as difficult topics for secondary school students in biology: exploring the impact of indigenous (cultural) knowledge for better understanding. *Breaking Barriers to Learning of Science: The CTC Approach*, 140-154.

Ornek, F., Robinson, W. R. & Haugan, M. P. (2008). What makes physics difficult?. *International Journal of Environmental & Science Education*, *3*(1), 30-34.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). SAGE Publications.

Rizaldi, D. R., & Fatimah, Z. (2024). Analysis of Various Contexts of Difficulties Experienced by Students in Learning Physics. *Physics Education Research Journal*, *6*(2), 103-108.

Rizaldi, D. R., Makhrus, M., Fatimah, Z., & Pineda, C. I. S. (2021). The Relationship Between Learning Style and Critical Thinking Skills in Learning Kinetic Theory of Gases. *Journal of Science and Science Education*, *2*(2), 72-76.

Rizaldi, D. R., Zaenudin, M., Fatimah, Z., Umami, B. E. (2022). Increase Student's Interest and Confidence in Continuing Study in Higher Education. *Innovare Journal of Education, 10*(3), 13-17.

Sandelowski, M. (2000). Whatever happened to qualitative description? *Research in Nursing & Health*, *23*(4), 334-340. https://doi.org/10.1002/1098-240X(200008)23:4<334::AID-NUR9>3.0.CO;2-G

Sigron, M., Langley, D., Dylak, S., & Yerushalmi, E. (2025). Longitudinal trends of high school physics students' perceptions of experience, difficulty, and development in a long-term inquiry framework. *Physical Review Physics Education Research*, *21*(1), 010101.

Sobel, M. (2009). Physics for the non-scientist: A middle way. *The Physics Teacher*, *47*(6), 346-349.

Şahin, E. & Yagbasan, R. (2012). Determining which introductory physics topics pre-service physics teachers have difficulty understanding and what accounts for these difficulties. *European Journal of Physics, 33*(2), 315-325.

Timur, B., Timur, S., Özdemir, M., & Şen, C. (2016). Challenges encountered in the teaching of units in the primary science course curriculum solution and recommendation/İlköğretim fen bilimleri dersi öğretim programındaki ünitelerin

öğretiminde karşılaşılan güçlükler ve çözüm önerileri. *Eğitimde Kuram ve Uygulama, 12*(2), 389-402.

Tuncel, M. & Fidan, M. (2018). Ortaokul fen bilimleri dersinde öğrenmede zorlanılan konular ve çözüm önerileri. H. İ. Kaya ve Ö. Demir (Edt.), *6. Uluslararası eğitim programları ve öğretim kongresi tam metin kitabı* (ss. 49-55). *Pegem Akademi*.

Üral, Y. & Yalçın, P. (2024). Determination of the subjects that students have difficulty in high school physics teaching with the opinions of high school physics teachers. *ISRG Journal of Education, Humanities and Literature (ISRGJEHL), I*(III), 8-11.