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Science Teachers' Views on Limiting Mathematical Relations for Some Subjects in Science Courses

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Abstract

The aim of science education in schools is for students to understand and know the universe. In this respect, each country updates its curriculum according to new approaches over time. In Türkiye, the science course curriculum in secondary schools has been revised again in 2024. The transition to the new curriculum will be made gradually. The 2018 science course curriculum is still being implemented in the 6th, 7th and 8th grades. In this curriculum, field-specific skills are classified as scientific process skills, life skills, engineering and design skills. Within the scope of science, engineering and entrepreneurship applications, students are expected to recognize a problem in daily life. In this respect, the relationship between the curriculum and mathematics teaching is at a high level. Students may need to use mathematical relations, especially in subjects such as force-motion, pressure and energy. However, it is seen that there are restrictions in the curriculum regarding not entering into mathematical relations for these subjects. In this study, the opinions of science teachers working in secondary schools were obtained regarding the restrictions regarding not entering into mathematical relations. A semi-structured opinion form consisting of 6 questions was prepared to obtain the opinions of the teachers. The teachers responded to this opinion form in writing. The answers given regarding the opinion form were examined according to qualitative data analysis methods. The necessary codes were created and themes were created. The opinions of the teachers were examined according to the created themes. The obtained results were examined in terms of the relationship between science teaching and mathematics teaching and suggestions were included.

Keywords: *Science Teaching, Mathematics Teaching, Science Course Curriculum, Science-Mathematics Teaching Relationship*

1. Introduction

Curriculums are an important tool that guides countries on how to provide education to their individuals. In this respect, each country reconsiders and revises their curricula according to new teaching approaches and technological developments. While doing this, the path followed by developed countries is also followed. It is effective in the results of international assessment exams (PISA, TIMSS etc.). It is seen that the curricula in Türkiye have been implemented based on constructivism since the 2000s. In 2024, a comprehensive revision was made in the curricula (Türkiye Century Maarif Model) (MEB, 2024) [1]. However, the implementation of this curricula will be gradual. The 2018 science course curriculum is currently being implemented in 6th, 7th, and 8th grades.

When looking at the 2018 science course curriculum;
-To provide basic information about astronomy, biology, physics, chemistry, earth and environmental sciences, and science and engineering applications,
-To adopt scientific process skills and scientific research approach to discover nature and understand the relationship between humans and the environment and to produce solutions to problems encountered in these areas,
-To develop career awareness and entrepreneurship skills related to science,
were some of the main objectives(MEB, 2018). [2].

In the 2018 science curriculum, field-specific skills are listed as follows;
-Scientific process skills
-Life skills (Analytical thinking, decision making, creative thinking, entrepreneurship, communication, teamwork)
-Engineering and design skills (Innovative Thinking)(MEB, 2018). [2].

In engineering and design skills, it is aimed to integrate science with mathematics, technology and engineering. In this way, it is aimed to provide students with the level of invention and innovation with an interdisciplinary perspective on problems (MEB, 2018). [2].

Mathematics is a branch of science that covers all areas. In the science curriculum, studies have been carried out to reveal interdisciplinary relationships in this respect. However, it is seen that the curriculum includes restrictions such as "Mathematical relations are not included" for achievements, especially in physics-related subjects (force-motion, pressure, work-energy, etc.). For example, in an achievement for 6th grades, the following restriction was made: *"F.6.3.2.1. Defines speed and expresses its unit. c. Mathematical relations are not included."* (MEB, 2018). [2].

With the inclusion of science, technology, engineering and mathematics (STEM) applications in the curriculum, it is seen that the number of studies revealing the relationship between science and mathematics has increased. In the study of Özarslan and Özcan (2022) [3], they examined the master's and doctoral theses in the YÖK thesis center between the years 2000-2018 with content analysis. In the studies after 2012, it was stated that the number of studies revealing the relationship between science and mathematics education has increased. Aytekin and Aydın (2017) [4] stated that the integration of science and mathematics would facilitate the understanding of the two courses. They also stated that the two courses complement each other. In the study of Çetin (2013) [5], they investigated why science teaching students should take mathematics courses. In the study, they determined that students care about mathematics and that mathematics courses are necessary for every field. Elliott et al. (2001) [6] investigated the effects of an interdisciplinary course called “algebra for science” on students’ critical thinking, problem solving and attitudes towards mathematics. It was observed that students who received interdisciplinary education had greater gains in critical thinking. Furner and Kumar (2007) [7] addressed the integration of science and mathematics education in their study. They emphasized the importance of the relationship between science and mathematics, especially by stating that physics contains more mathematics. Temel, Dündar and Şenol (2015) [8] aimed to determine the difficulties that science teachers experience due to mathematical concepts and expressions. What was done to eliminate these difficulties and why the integration of science and mathematics is important were investigated. Türkan, Karakuş and Karakuş (2012) [9] obtained the opinions of science and primary school mathematics teachers in their study. As a result of the research, it was seen that the relationship between science and mathematics is important and that the course with which science is most associated is mathematics.

When the results of the studies are examined, it is seen that the relationship between science and mathematics education is at a high level. In this respect, the interdisciplinary relationship should be taken into account in science courses and sufficient information in the field of mathematics should be included.

2. Purpose of the Research

The integration of science education and mathematics education is important. According to the results of the study above, the more the relationship between science and mathematics education is provided, the better students will be able to understand these concepts. In this respect, it is important to include the views of teachers who are the implementers of the curriculum on the limitation of mathematical relations. In this way, the practices of teachers in the process can be revealed and the necessary teaching environments can be created.

2.1. Problem Statement

The problem statement for the research was created as "What are the views of teachers on the limitation of mathematical relations in science courses?"

3. Method

Qualitative research methods were chosen in the study. In qualitative research, researchers want to obtain a much broader perspective when conducting research on a certain subject, rather than learning "how much" or "how good" that subject is. Qualitative research provides more in-depth information about social events than quantitative research methods (Büyüköztürk et al., 2010).[10].

3.1. Research Model

A case study was selected from qualitative data analysis models in the study. In case studies, the aim is to define the details that create an event (Büyüköztürk et al., 2010). [10]. However, case studies also have different applications. In this study, a case analysis was selected. In a case analysis, the aim is to examine a specific event using a different perspective(Büyüköztürk et al., 2010). [10].

3.2. Study Group

25 science teachers working in secondary schools who were willing to participate in the study were included. When selecting the teachers, care was taken to ensure that they were from schools where undergraduate students were doing their internships. In this way, data was tried to be collected more accurately. The distribution of the study group according to variables is as follows;

Gender		Working Years				Educational Status	
Female	Male	1-5 Years	6-10 Years	11-15 Years	16 ve ---	Undergraduate	Master's Degree
15	10	5	7	3	10	17	8
25		25				25	

3.3. Data Collection Tool

The aim of the study was to explain a situation in depth using a qualitative research method. For this purpose, the "Teacher Opinion Form on Limiting Mathematical Relations in Science Lessons" was developed to obtain the opinions of science teachers. This form contains 6 questions created in a semi-structured manner. Teachers responded to the questions in the interview form in writing.

3.4. Data Analysis

The obtained data were examined according to content data analysis. The opinions form responses were organized, coded, summarized and interpreted. It is stated that categorical combination can be made in case studies. In categorical combination, data is coded and examples are collected from which meanings will emerge (Büyüköztürk, 2010). [10]. In this respect, categorical combination was made in the study. The responses given were classified and the frequency values related to them were determined.

4. Findings

The answers given by the teachers to the questions in the semi-structured interview form are given below.

4.1. Do you find it necessary to limit mathematical relations for some achievements in the 2018 Science Course Curriculum? Explain.

The answers given by the science teachers to this question are explained in Table 1.

Table 1. Teachers' Views on Whether a Restriction on Not Entering Mathematical Relations in the Science Course Curriculum is Necessary

Opinion	f	Reason*
Required	9	-In previous years, I used to go into mathematical relations. When I see the explanation, I don't give the relations anymore. (f=2) -Students are not successful in mathematics. (f=2) -Students cannot focus. (f=1) -They memorize the formula and solve the question. They cannot integrate it with the logic of the question or the subject. (f=2) -It makes it difficult to learn the subjects. (f=3) -It is more important to understand and analyze the subject rather than solving the question. (f=1) -Those who do not like mathematics may not like this course if they see mathematical subjects in science courses. (f=1) -It makes it difficult to learn the subjects. (f=3)
Not Required	16	-Mathematical relations are important in science classes. (f=3) -It makes the subjects easier to understand. (f=4) -Mathematical relations are simple relations. (f=4)

		-It is suitable for the level of secondary school students. (f=3) -It is important for interdisciplinary education. (f=1) -Using formulas helps students develop different solution strategies. (f=2) -It ensures that the subjects are understood and have concrete forms. (f=1) -They will encounter more complex mathematical relations in high school. (f=2) -Verbal information remains abstract. (f=1) -Students do not understand density calculation, speed calculation, pressure, force transformations without doing mathematical operations. (f=1) -The subjects go parallel with mathematics classes. (f=1)

**Since teacher opinions include more than one proposition, the sum of opinion frequencies is different from the total number of teachers.*

When the data in Table 1 is examined, it is seen that the teachers stated that it is not necessary to make a limitation for mathematical relations in the outcomes (f=16). The reasons for this are that mathematical relations are simple, they make the subjects easier to understand, they are suitable for the students' levels, and science and mathematical relations are important. Teachers who think that there should be a mathematical limitation stated that it makes the subjects difficult to learn and that it is important to understand the logic of the subject.

4.2. Do you use mathematical relations in science classes? Explain whether your answer is positive or negative.

The answers given by science teachers to this question are explained in Table 2.

Table 2. Teachers' Views on Using Mathematical Relations in Science Classes

Opinion	f	Reason
I give the mathematical relations.	20	-I make them comment on relations. (f=1) -I don't make them solve questions with relations. (f=1) -It makes things easier in subjects that require calculations. (f=5) -I use mathematical relations by writing formulas. (f=2) -It makes learning easier when comparing kinetic and potential energy. (f=1) -I use mathematical relations to make it familiar and to reinforce the subject. (f=2) -I give it in 8th grades. (f=2) -I explain it both conceptually and as a relation. (f=4) -Without knowing mathematical relations, one cannot understand science subjects. (f=3) -Questions prepared from different sources cannot be solved without using formulas. (f=2) -In speed calculations and graph examinations, one needs to use mathematical relations. (f=1) -I say that there is such a formula, although it is stated that it should not be included in the achievement. (f=1) -Students love mathematics. (f=1) -The subject is better understood with mathematical relations. (f=6)
I do not give the mathematical relations.	5	-It causes students to memorize.(f=1) -If a mathematical relation is required in the subject, I give it (For example, finding the pressure of a solid).(f=1) -Because the curriculum does not require mathematical relations.(f=2) -The process is important in understanding the subject.(f=1) -It is impossible to be completely formula-free.(f=1)

When the data in Table 2 is examined, it is seen that the majority of teachers (f=20) explain the lesson by using mathematical relations. The reason for this is that science lessons cannot be understood without knowing mathematics, it provides convenience in subjects that require operations, and students understand the subjects better with mathematical relations. Those who do not use mathematical relations stated that the curriculum imposes such a limitation and that the process is important in understanding the subject.

4.3. When teaching some subjects in science classes (pressure, force-motion, simple machines, etc.), is it difficult for you to teach the subject without going into mathematical relations? Explain.

The answers given by the teachers regarding this question are given in Table 3.

Table 3. Teachers' Opinions on Whether It Is Challenging to Explain Some Subjects in Science Courses Without Making Any Mathematical Connections

Opinion	f	Reason
No, it is not challenging.	5	-It is not difficult for them to comment and understand the subject. (f=1) -It can be difficult to solve when a question comes from a different source. (f=1) -It can be explained without any relations. (f=1) -I support it with mathematical relations. (f=1) -Visual experiments seem more interesting. (f=1) -There may be little time to complete the curriculum. (f=1)
Yes, it is challenging.	20	-It is difficult if students do not have sufficient mathematical knowledge. (f=1) -I mostly relate the subjects to daily life. (f=1) -It is difficult to comment and make logic. (f=1) -Students ask why it is not explained with a small operation. (f=1) -It can take a long time to explain the importance of mass and speed when explaining kinetic energy. (f=1) -Because they understand more easily with mathematical relations. (f=6) -The subject does not become concrete and is not understood. (f=1) -Physics subjects are subjects that involve numerical data and comparisons. (f=1) -Formulas provide an advantage for those who know mathematics well. (f=3) -It is difficult to teach the subject without going into mathematical relations.(f=2) -In some sources, students may encounter questions that include mathematical relations.(f=1) -It may be difficult for 8th graders to understand without mathematical relations.(f=1)

When the data in Table 3 is examined, teachers stated that they had difficulty when they did not include mathematical relations while explaining subjects related to the field of physics (f=20). The reason for this was that they could easily understand with mathematical relations and that it provided an advantage for those who knew mathematics. Teachers who stated that they did not have difficulty while explaining subjects related to the field of physics stated that the reason for this was that visual experiments were more interesting and that they could be explained without relations.

4.4. In which situations do you think students understand the subject better in science classes when the subjects are explained without mathematical relations and by giving these relations? Explain.

The answers given by the teachers regarding this question are given in Table 4.

Table 4. Teachers' Views on Comparison of Students' Understanding of the Subject in Cases Where Subjects Are Explained Without and by Providing Mathematical Relations in Science Courses

Opinion	f	Reason
Students understand better by providing mathematical relations.	18	-Force, heat-temperature, pressure topics require mathematical relationships. (f=1) -For mirrors, lenses topics require relationships. (f=1) -Mathematical relationships shorten the time to understand. (f=2) -Question solutions become easier. (f=1) -The logic of the topic should be understood without memorizing formulas. (f=2) -Mathematical relationships are required for density, graphic interpretation, simple machines, force-motion topics. (f=1)

		-When mathematical relationships are entered, the topic becomes understandable. (f=3)
Students understand better without giving mathematical relations.	7	-They do it easier. (f=1) -Systems, sky, space topics are easily understood without mathematical relations. (f=1) Students with little knowledge of mathematics have difficulty understanding the subject. (f=1) -When mathematics is included in relations, students can be negatively affected. (f=2) -Central common exams (LGS etc.) are based on knowledge, interpretation and understanding what they read. (f=3) -When there is a formula, no effort is made to understand. (f=1)

When the data in Table 4 is examined, most of the teachers (f=18) stated that when mathematical relations are included in the subjects, students understand the subject better. The reasons for this are that mathematical relations make understanding easier and are necessary especially in subjects related to the field of physics. Teachers who do not include mathematical relations in the explanation of the subjects stated that they learn the subjects more easily and that they are negatively affected when they see mathematics.

4.5. Do you think that students in science courses need mathematical relations in solving questions while preparing for the central placement exams (LGS)? Explain.

The answers given by the teachers regarding this question are given in Table 5.

Table 5. Teachers' Views on the Need for Mathematical Relations in Solving Questions While Preparing for Central Placement Exams in Science Courses

Opinion	f	Reason
They need mathematical relations.	17	-Students solve questions more easily in subjects that require mathematical relations. (f=1) -Questions based on interpretation. However, they also require mathematical relations. (f=1) -Most students solve questions more easily with mathematical relations. (f=1) -Mathematical operations may be required depending on the type of question. (f=3) -Direct proportion, inverse proportion, four operations, etc. should be used in lessons. (f=1) -Mathematical relations are needed in pressure and simple machines. (f=3) -Students do not trust interpretation when solving questions. (f=1) -They want to prove the result mathematically. (f=1) -Some questions can be solved more easily with mathematical relations. (f=1) -Mathematical relations are given verbally in the questions and students are asked to understand what they read. (f=1) -There may be questions where mathematical relations are used in different sources. (f=1)
They don't need mathematical relations.	8	-LGS exams consist of commentary questions. (f=5) -Higher-level thinking skills should be taught rather than mathematical relationships. (f=1) -Questions can be solved by establishing simple proportions for the exam. (f=1) -Mathematical expressions are necessary when explaining the basics of the topics. (f=1)

When the data in Table 5 is examined, it is seen that teachers stated that students need mathematical relations (f=17) when solving central exam questions. The reason for this is that the type of question requires operational skills, mathematical expressions are given verbally in the questions but they want to understand them. Teachers who said that mathematical expressions are not needed stated that the questions can be solved using simple proportions for the exam and that LGS exam questions are comment questions.

4.6. Which topics in Science courses do you think will contribute to students understanding the subject better if mathematical relations are given? Explain.

Teachers' answers to this question are shown in Table 6.

Table 6. Teachers' Views on Which Topics in Science Courses Would Be Better Understood by Students if Mathematical Relations Were Used to Teach Them

Subject	f
-Speed, pressure, force-motion	15
-Graph reading and questions involving graphs	2
-Simple machines	13
-Work and energy	9
-Topics related to the field of physics	1
-Density	5
-Heat and temperature	3
-Not necessary in any subject.	1
-Solid pressure	1
-Liquid pressure	1

When the data in Table 6 is examined, teachers generally stated that success can be achieved if mathematical expressions are included in subjects related to the field of physics. The most important of these subjects are speed, pressure, force-motion, simple machines, work-energy.

5. Conclusion and Discussion

Science teaching and mathematics teaching are interrelated courses. Interdisciplinary studies are emphasized in the developed curriculum. In this respect, sufficient mathematical relations should be included in science courses. When the research results are examined, it is seen that the majority of teachers state that there should be no restriction on not including mathematical relations in science courses. The reason for this is that the relationship between science and mathematics is important and that the understanding of the subjects becomes easier. Again, although there is a restriction on not including mathematical relations in the curriculum, it is seen that teachers provide these relations in some subject content. It is seen that teachers have difficulty in explaining the subject without including mathematical relations, especially in teaching physics-content subjects. It is one of the results that students learn the subjects more easily when the subjects are explained by including mathematical relations. It is seen that mathematical relations are necessary for central common exams. The subjects where mathematical relations should be given are; force-motion, pressure, work and energy, density, etc. It was seen that there were topics related to the field of physics. When the results obtained are examined, the importance of integrating science courses with mathematics courses becomes clear. It can be said that the results presented are compatible with (Furner and Kumar, 2007; Elliot et al., 2001; Aytekin and Aydın, 2017; Türkan, Karakuş and Karakuş, 2012).[7, 6, 4, 9].

Based on this, the following suggestions can be made;

-The limitations regarding not including mathematical relations in the learning outcomes or student gains in science course curriculums can be removed.

-Science courses can be associated more with mathematics courses.

-Arrangements should be made so that students can understand the whole subject and at the end of the process, teaching activities should be created where they can do mathematical modeling.

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