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CURRICULUM DEVELOPMENT BASED ON AN INTERDISCIPLINARY CONTEXT-BASED LEARNING APPROACH IN THE CONTEXT OF ELECTRICITY AND MAGNETISM

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Abstract: *This research is a needs analysis study aimed at developing a curriculum based on an interdisciplinary context-based learning approach within the 10th-grade physics course, focusing on the electricity and magnetism unit. The research was designed according to the case study model and data were collected from expert, teacher, and student sample groups through questionnaires and interview forms. Descriptive statistics were utilized for quantitative data analysis, while content analysis technique was employed for qualitative data. The results indicated that the physics curriculum continued to maintain a disciplinary perspective and a classical understanding of physics, with insufficient connection with daily life and adaptation to contemporary conditions. Similar results were identified in the 10th-grade physics textbooks and in-class instructional practices concerning the unit of electricity and magnetism. In this respect, the research identified the needs for developing a curriculum based on an interdisciplinary context-based learning approach to address these negative results. These needs, while enhancing interdisciplinary context-based understanding, can also contribute to the emergence of various opportunities and different perspectives in physics education. It is recommended to identify needs in other subfields of physics as well and develop curricula designed with an interdisciplinary context-based approach for more effective and efficient physics education.*

Keywords: *interdisciplinary understanding, context-based learning, electricity and magnetism, physics education, high school students*

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Introduction

Physics, as one of the natural sciences, examines the fundamental laws governing the secrets of our environment, nature, and the universe. It also contributes significantly to individuals' understanding of daily life, development of thought systems, and analysis of relationships between science, technology, society, and the environment. The increasing occurrence of natural phenomena, expansion of subject content, variation in study methods, and evolving outcomes over time have led to the emergence of subfields within physics such as mechanics, optics, thermodynamics, quantum physics, and atomic physics. Additionally, they have contributed to the development of new branches of science such as biophysics, physical chemistry, astrophysics, and geophysics (Çalışkan, 2007; Gök, 2006). As it is evident, physics not only exists concretely in our lives but also facilitates the development of new practical applications in practice (Neito et al., 2023). However, research has shown that physics is perceived as theoretical, abstract, complex, formula-driven, disciplinary, intensive, and independent of everyday life experiences (Abak, 2003; Bahtaji, 2023; Henriksen et al., 2004). In order to address this negative perception towards physics and to enhance more effective physics education, various projects have been developed and implemented in many countries. These include the Supported Learning in Physics Project, Salters Horners Advanced Physics, Physik im Kontext, Dutch Physics Curriculum Development Project and NINA, as well as projects like The Relevance of Science Education, Science, Technology, Environment in Modern Society, and Designing the Brain in an Appropriate Manner (Demkanin et al., 2022; Kortland, 2007; Parker et al., 2000; Whitelegg & Edwards, 2001). In this context, in line with the constructivist approach, similar changes have been attempted in the physics curriculum and practices in Turkey since 2007 (Bülbül et al.,2019). However, research has shown that the desired level of success has not been achieved (Ayvacı et al., 2015; Bezen et al., 2020). The main reasons for this situation include the disciplinary nature of the subject content in the curriculum, perceiving the content solely as subject matter, the structuring of physics textbooks based on a disciplinary approach, frequent use of teacher-centered teaching

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methods and techniques, disregarding student experiences, interests, and abilities, and conducting outcome- and performance-based measurement and evaluation (Aytekin, 2022; Demkanin & Novotná, 2021). To address these shortcomings, the process of answering and structuring questions such as 'What are the goals in physics education? Why? Which competencies should be developed? Which methods and activities should be employed? At what age level? And what complex problems are ideal?' gains significance (Demkanin, 2020). Associating physics with an interdisciplinary understanding in this process not only facilitates the comprehension of new ideas but also positively enhances students' knowledge, skills, and attitudes when these are systematically integrated into the curriculum (Manolea, 2014; Miron & Staicu, 2010). An interdisciplinary approach is the process of bringing together the distinctive components of two or more disciplines, facilitating interaction, organizing the lessons with each other (Meredith & Bolker, 2012; Oleg, 2015), and integrating concepts and/or skills belonging to multiple disciplines (Bae, 2009). Research shows that instruction based on interdisciplinary understanding enhances scientific thinking, reasoning, and problem-solving skills, fosters meaningful learning, and integrates knowledge and skills related to physics (Yu et al., 2021; Nousiainen & Koponen, 2017). The structuring of physics curriculum and practices with an interdisciplinary understanding addresses disparities and fragmentation in physics education by integrating relevant needs (Park & Liu, 2016). Considering the relevant literature, interdisciplinary studies conducted within the scope of physics education are limited in number. Studies conducted in Turkey focused on energy (Demir, 2008; Güneş & Akdağ, 2015), "living organisms and life", "energy", "matter and change" (Bozkurt, 2012), energy resources (Yolcu, 2013), heat and temperature (Tekerek & Cebesoy, 2017). Other studies in international context focused on light (Cervetti et al., 2012), energy (Lancor, 2015; Park & Liu, 2016), chaos theory (Bae, 2009), the correlation between physics and philosophy (Oleg, 2005), electromagnetic waves (Woźniak et al., 2020), and mechanics (Descamps et al., 2020). In this matter, there is a further need to do interdisciplinary studies involving various topics in physics.

In order for students to understand interdisciplinary relationships and the integrity related to electricity and magnetism, the curriculum should be tailored to the needs of the students, meaningful for them, and embodying their relationships with the physical world. In other words, students should be able to find answers to questions such as "Why?", "How?", and "What will happen if it becomes like this?" in the context of science, society, and the environment during the learning process (Descamps et al., 2020). One of the learning approaches addressing all these needs is the context-based learning approach. Context refers to the coherence and relationships between the selected real-life situations from everyday life, social events, and scientific practices (King, 2012). The context-based learning approach involves conducting instructional practices based on a phenomenon or event from everyday life (Yu et al., 2014). In the context-based learning process, students learn concepts not as isolated pieces of information but through contexts established with the social structure of their community, cultural characteristics, and their own life experiences (Choi & Johnson, 2005). Research shows that the context-based learning approach contributes to enhancing students' skills in being aware of society, transferring knowledge to daily life, and establishing relationships among physics-technology-society-environment, while also contributing to their learning interest, motivation, and awareness of social responsibilities (Ellis & Gabriel, 2010; Jonsson et al., 2007). In this regard, there is a need for the development and implementation of programs based on an interdisciplinary context-based learning approach in physics courses. Interdisciplinary context-based learning facilitates advanced physics learning for students, fosters the development of different perspectives, increases curiosity towards exploring the universe and nature, promotes the formation of positive emotional and cognitive combinations, and enables the cultivation of lifelong learning and raising qualified individuals who utilize it (Kaltakçı Gürel, 2017; Hofstein & Kesner, 2006). In physics education, alongside the interdisciplinary context-based learning approach, the choice of subject context is also essential. In this respect, in the research, the topic of electricity and magnetism is addressed for multiple reasons: the subject being taught at all levels of education (Kotoka & Kriek, 2023), and physics being a fundamental, intersecting, and inclusive field within all its sub-disciplines (Serway & Beicher, 2007). For instance, it contributes to the comprehensive understanding of various aspects such as the movement of molecules in our bodies, normal force, frictional force, air resistance, elasticity, reactions at the nuclear scale, and the development of technological devices in daily life (Serway & Beicher, 2007; Stratton, 2007). Therefore, it is necessary for electrostatics, electric current, magnetism, and the relationship between electricity and magnetism, which are included in the content of electricity and magnetism, to be learned and taught meaningfully (Magana & Balachandran, 2017). Otherwise, the misconceptions that arise would not only hinder the understanding of electricity and magnetism but also make it difficult to comprehend physics and, thus, the nature we live in. In the relevant literature, the most commonly encountered misconceptions include: electricity only exists in moving charges, electric current is generated by collisions of charges, magnetic field lines start from one pole and end at the other, magnetic flux creates an induced electromotive force (emf), magnets attract all metals, the magnetic attraction force of a magnet is similar to that

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of the Earth, magnetism is formed by charge transfer, and more (Campos et al., 2021; Cao & Biruzuella, 2016; Hekkenberg et al., 2015; Kesonen et al., 2011; Melo-Niño et al., 2017). Additionally, the same studies have shown that students, despite understanding the theory of electricity and magnetism, are unable to apply it to relevant laws. They perceive the subject merely mathematically, and teachers tend to conduct the teaching-learning process with a classical physics understanding, not placing enough importance on the subject.

According to Moore (2018), these negative aspects stem from the relatively low number of learning outcomes related to electricity and magnetism in physics curriculum and the abstract nature of some learning outcomes and the superficial treatment of topics. Students' deficiencies in mathematical operations, lack of mastery in basic physics topics (Melo-Niño et al., 2017), teaching based on classical physics understanding (Cao & Brizuela, 2016), the use of teaching methods and techniques that do not match the student level (Dega et al., 2012), and inadequate time allocated for measurement and evaluation (Mbonyiryivuze et al., 2022) are cited as other contributing factors. Campos et al. (2021) and Nousiainen and Koponen (2017) also emphasize the abstract nature of the topic of electricity and magnetism. They suggest paying attention to the historical development of the subject during instruction and emphasize the importance of establishing conceptual connections not only within the subfields of physics but also with other disciplines. For instance, the breaking of chemical bonds between molecules, electrostatic forces between charged particles, and the release of chemical energy can be associated with biology, chemistry, and physics (Becker & Cooper, 2014). In this regard, there is a recognized need to develop a curriculum for teaching electricity and magnetism based on an interdisciplinary context-based learning approach. As the first step in curriculum development, this study employed a needs analysis for the curriculum (Oliva, 2005). Needs analysis studies form the basis for the design, implementation, and evaluation stages of relevant curricula. The results obtained from this research study are important for determining the prior knowledge of students about the subject, identifying what they want to know, shaping the educational services that need to be provided, and revealing the educational needs of a changing society. Furthermore, the research focusing on effective physics education is also significant in clarifying some complex and incomprehensible processes experienced in both physics and electricity and magnetism. In light of all these explanations and justifications, the following questions were addressed in this research.

1. What are the views regarding the physics curriculum?
2. What are the views regarding the 10th grade electricity and magnetism unit of the physics curriculum?
3. What are the views regarding the electricity and magnetism unit in the 10th grade physics textbook of the Ministry of National Education (MoNE)?
4. What are the views regarding the implementation process of the 10th grade electricity and magnetism unit in the classroom?
5. What are the suggestions for improving the electricity and magnetism unit?

Research Methodology

Research Model

The researchers employed a qualitative case study research design. A case study involves an in-depth description and analysis of one or more real-life entities (e.g., environment, social group, and individual) within a limited system (Ellinger & McWhorter, 2016). The case examined in this research involved determining the needs of the curriculum developed based on an interdisciplinary context-based learning approach within the scope of the physics course's electricity and magnetism unit. In this respect, the research is in a holistic single-case design.

Participants

Three different groups were involved in the research: teachers, students, and an expert group. Data were collected in two stages, using both quantitative (questionnaire) and qualitative (interview) methods.

Teacher Group: To determine the participants, firstly, the list of high school education institutions in the central districts (Çukurova, Seyhan, Yüreğir, and Sarıçam) was compiled from the official website of the Adana Provincial Directorate of National Education. Then, the websites of schools were examined, and it was determined that a total of 267 physics teachers were working in schools in the city center of Adana. School visits (face-to-face) and email communication enabled contact with 172 of these teachers, and 164 teachers volunteered to participate in the research. Of these participants, 71 were women and 93 were men. Most teachers worked in Anatolian high schools

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(*n* = 86), followed by vocational (*n* = 52), Imam Hatip (*n* = 18), and science high schools (*n* = 8), respectively. The majority of teachers were graduates of education (46.3%) and science and literature (45.1%) faculties. Their years of service varied as follows: 1-5 years (12.8%), 5-10 years (14.6%), 10-15 years (25.0%), 20-25 years (24.4%), and 25+ years (23.2%). Ten teachers volunteered to participate in the interview stage, with five male and five female participants. They worked in Anatolian (*n* = 6), vocational (*n* = 3), and Imam Hatip *(n* = 1) high schools. These participants had 10-15 (60%) and 15-20 (40%) years of teaching service. Four of the teachers had master's degrees, while the others had undergraduate degrees. One was a physics engineering graduate, three were science faculty graduates, and the others were education faculty graduates.

Student Group: A total of nine schools were determined through a criterion sampling (academic achievement, the socioeconomic status of the school environment, and the physical equipment of the school) from the list of schools prepared to form the teacher group. The general academic success of schools was determined considering the results of the central exams for high school and secondary school obtained from the internet and school administration. While determining the socioeconomic and cultural characteristics of the school environment, the researchers took into account the districts/neighborhoods where the schools were located and the explanations provided by the teachers. Regarding the physical facilities of the schools, attention was paid to the presence of a physics laboratory, materials, and so forth. In this context, a total of nine schools were selected, with three schools from each of the lower, middle, and upper socioeconomic environments. Subsequently, contact was made with the administrators and physics teachers of these schools to obtain information about the overall academic achievements of grades 9-12, their achievements in physics, and their willingness to participate in such a study. Based on the information obtained, one class from each grade level was selected in each school to ensure heterogeneity, and on the day of implementation, data collection tools were provided to all students in the classroom. A total of 484 students volunteered to participate in the research. Of these students, 61% were female and 39% were male. Further, 14.9% of the participants attended science high schools, 54.3% attended Anatolian high schools, 17.4% attended vocational high schools, and 13.4% attended Imam Hatip high schools. Of these students, 23.4% were in the 9th grade, 24% in the 10th grade, 27.7% in the 11th grade, and 24.8% in the 12th grade. The students selected for interviews were determined based on their general academic achievement, different levels of success in physics class, being in the 11th or 12th grade, and their willingness to participate in interviews. Six of the students were male, and four were female. Seven students were from Anatolian high schools, two from vocational high schools, and one from an Imam Hatip high school. Five of the students were 11th graders, and five were 12th graders. Considering their physics and overall academic achievement levels, four students were high achievers (with a grade point average of 85-100), four were medium achievers (with a grade point average of 60-84), and two were low achievers (with a grade point average of 60 and below).

Expert Group: Of the experts participating in the interview process, four were women and four were men. Their fields of expertise were physics education (*n* = 4), measurement and evaluation (*n* = 2), and curriculum and instruction (*n* = 2). They held academic titles of professor (*n* = 3), associate professor (*n* = 3), and doctorate (*n* = 2). They worked in universities (*n* = 6), the Ministry of National Education (*n* = 1), and private educational institutions (*n* = 1).

Data Collection Tools

Questionnaire: A "Physics Curriculum Evaluation Questionnaire" was developed in two separate forms for teachers and students to identify the need for curriculum development in the research. During the development process of the questionnaires, the questionnaire development stages outlined in Büyüköztürk (2005) were followed. *Problem Definition*: Studies conducted on the MoNE's physics curriculum and related literature were examined within the scope of evaluating the physics curriculum. *Item writing (creating a draft form)*: Eight physics teachers serving in different types of high schools (convenient accessible sampling) were consulted for their opinions, and volunteer students studying in their classes were interviewed, and questionnaire items were written. *Seeking expert opinions*: The prepared questionnaire items were presented to two experts in curriculum and instruction, two experts in measurement and evaluation, one expert in physics education, and two physics teachers. Based on the information obtained from expert interviews, irrelevant items were removed, and the wording of some items was corrected. As a result, the teacher questionnaire, initially prepared with 65 items, was reduced to 55 items, while the student questionnaire, initially prepared with 71 items, was reduced to 64 items. *Piloting and finalizing the questionnaires*: The prepared forms underwent a pilot test with 30 physics teachers and 145 students, and the questionnaires were finalized.

Interview Form: The interview forms prepared for experts, teachers, and students were used to analyze the

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current status of the place and implementation process of the "Electricity and Magnetism" unit in the physics curriculum. The interview forms were prepared within the scope of the relevant literature and presented to two experts in curriculum and instruction and one expert in physics education. As a result of the feedback received, the questions were revised and finalized. In the *expert form*, there were five questions addressing opinions, expectations, and suggestions for improvement regarding the learning outcomes, content, teaching-learning process, and assessment of the "Electricity and Magnetism" unit in the physics curriculum. The *teacher form* included six questions addressing their opinions, expectations, and suggestions for improvement regarding the learning outcomes, content, teaching-learning process, and assessment of the "Electricity and Magnetism" unit in the physics curriculum, as well as their opinions on the instruction process and assessment of this unit and their thoughts regarding the textbook. The *student form* included seven questions addressing opinions, expectations, and suggestions for improvement related to the content, instruction process, and assessment of the "Electricity and Magnetism" unit in the physics curriculum, and their thoughts regarding the textbook.

Data Collection

In the research, initially, the overall situation regarding the physics curriculum was determined through questionnaires. Subsequently, interviews were conducted with expert, teacher, and student groups to analyze the current state of the 10th-grade "Electricity and Magnetism Unit." The data were collected during the spring semester of the 2016-2017 academic year and the fall semester of the 2017-2018 academic year. The questionnaires were administered by the researcher, and care was taken to ensure that the education process was not disrupted by using a class hour deemed appropriate by the teachers. Teacher and student interviews were conducted face-to-face within the school premises, in locations such as the laboratory, library, or vacant classrooms. Teacher interviews lasted 15 minutes on average, while student interviews lasted 10-15 minutes on average. After obtaining their permission, audio recordings were made during the interviews. Three of the interviews with experts were conducted face-to-face, while five were conducted through written interview methods.

Data Analysis

Descriptive analysis methods (arithmetic mean and standard deviation) were used for the quantitative data collected through questionnaires. Content analysis (deductive and inductive analysis) and descriptive analysis approaches were used together for the qualitative data collected through the interview forms. In this context, the interview texts were transferred to the Word program on the computer, resulting in a total of 110 pages of raw data. Subsequently, coding was conducted using the NVIVO 11 PRO program, establishing relationships between identified themes and codes to integrate the data in a meaningful way. For coding reliability, the raw textual data were read and coded by a second coder. Subsequently, inter-coder reliability was calculated using the formula, Reliability = Agreement / (Agreement + Disagreement) * 100, proposed by Miles and Huberman (1994). As a result of the calculations, the coding reliability for teacher, student, and expert opinions was calculated as 92%, 91%, and 94%, respectively. In presenting the findings, care was taken to be explanatory and provide frequent direct quotations.

Research Results

Opinions of Teachers and Students on Physics Curriculum

Table 1 shows the findings obtained from the teachers.

Table 1
Opinions of Teachers on Physics Curriculum

	Opinions	$\bar{x}$	*SD*
	Learning Outcomes		
1	They are achievable.	3.71	0.78
2	Their wording is clear, precise, and understandable.	3.66	0.76

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	Opinions	$\bar{x}$	*SD*
3	They are patterned according to educational principles (from simple to complex, concrete to abstract, and known to unknown).	3.51	0.89
4	They are of adequate quantity.	3.43	0.92
5	They are consistent with the curriculum goals.	3.50	0.97
6	The learning outcomes are interrelated or complementary to each other.	3.70	1.12
7	They are related to the content of the course (e.g., concepts, explanations, principles, and generalizations).	3.84	1.09
8	They are suitable for students' cognitive development levels (e.g., understanding, interpreting, comparing, and more).	3.51	1.12
9	They are suitable for students' affective development characteristics (e.g., interest, desire, positive attitude, and more).	2.89	1.09
10	They are suitable for students' psycho-motor development levels.	3.28	0.91
11	The learning outcomes are behavior-oriented for students.	3.54	1.11
12	They aim to enhance students' higher-order thinking skills (e.g., critical thinking, creative thinking, problem-solving, and more).	2.76	1.03
13	The learning outcomes are related to daily life.	2.91	1.13
	Contents		
1	They are aimed at achieving the learning outcomes.	3.72	0.97
2	They suit students' interests, needs, and requirements.	3.13	0.88
3	They are clear and explicit in terms of language and expression.	3.54	1.11
4	They reflect scientific knowledge.	3.66	1.02
5	They are learnable and meaningful for students.	3.35	1.05
6	They are related to life/functional.	2.95	0.94
7	They reflect the latest developments in the subject area and are up-to-date.	3.52	0.99
8	The topics support each other and are consistent.	3.69	0.77
9	The depth of the topics (details) is balanced.	3.30	1.10
10	They are related to other courses, and topics/interdisciplinary.	2.58	1.05
11	The contents are supported with domain-specific tables, figures, diagrams, and examples.	3.44	1.08
12	They are organized in a way that facilitates students' comprehension.	3.49	1.16
13	They can enhance students' thinking abilities.	2.84	0.93
14	They include arrangements for students to use and apply what they have learned.	3.14	0.98
15	They are suitable for conducting different teaching-learning activities.	3.57	1.17
16	The learning topics and activities are consistent with each other.	3.25	0.88
17	They include arrangements (exercises) for students to review what they have learned.	3.47	1.21
	Teaching-Learning Process/Instructional Activities		
1	The teaching-learning process of the curriculum is clear and understandable.	3.57	0.75
2	Its learning outcomes are achievable.	3.51	0.90
3	It is suitable for the age and developmental characteristics of students (cognitive, affective, and psycho-motor).	3.52	0.94
4	It takes into account the characteristics of the topics (e.g., concrete-abstract, simple-complex, and easy-difficult).	3.61	0.95
5	It provides teachers with the opportunity to use different teaching approaches.	3.55	1.02
6	The activities in the teaching-learning process are applicable outside the school and classroom setting.	3.56	0.97
7	It establishes interdisciplinary relationships in instructional activities.	2.58	1.22
8	It includes individual and group work activities.	3.17	1.24
9	It can enhance students' higher-order thinking skills (critical thinking, creative thinking, and problem-solving).	3.34	0.97
10	The recommended tools and materials can support students' learning.	3.27	1.07
11	The methods and techniques employed ensure the active participation of students in lessons.	3.23	1.15

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	Opinions	$\bar{x}$	*SD*
12	The activities are prepared in accordance with instructional principles (e.g., From easy to difficult, economical, relevant to life, from simple to complex, and more).	3.59	1.06
	Measurement and Evaluation		
1	The explanations regarding measurement and evaluation provide guidance for the teacher.	3.15	0.91
2	The measurement tools can measure the objectives of the lesson (e.g., scientific knowledge, scientific processes, and the relationship between science, society, technology, and the environment).	2.84	1.03
3	They are related to the teaching-learning process and activities.	3.44	1.12
4	The evaluation criteria are clear and explicit.	3.03	0.92
5	The examples provided for measurement and evaluation are sufficient.	2.62	1.09
6	The recommended measurement tools are suitable for students' developmental characteristics.	3.52	1.07
7	The measurement tools for measuring and evaluating the learning process are sufficient in quantity.	2.95	0.91
8	The measurement tools for measuring and evaluating learning products are sufficient in quantity.	3.09	0.94
9	The measurement tools are applicable.	3.52	1.22
10	They can measure students' higher-order thinking skills (critical thinking, creative thinking, and problem-solving).	3.28	1.09
11	They can determine establishing interdisciplinary connections.	2.67	0.98
12	The evaluation results provide information about areas that are lacking in the curriculum, need improvement, or require additions.	3.18	1.17
13	They also base measurement and evaluation on out-of-class activities.	3.49	1.51

As observed in Table 1, teachers' views on the physics curriculum were moderately positive for all dimensions. Teachers' relatively negative views on learning outcomes were related to the relevance of the learning outcomes to everyday life, the development of higher-order thinking skills, and addressing the emotional characteristics of students. Highlights regarding the curriculum contents included their failure to establish connections with other subjects and topics, their lack of relevance to life or functionality, and their failure to enhance students' thinking skills. Shortcomings in the teaching-learning process included the absence of interdisciplinary connections in instructional activities, the lack of active participation in the class, and not conducting individual and group work activities. Teachers found the examples for measurement and evaluation purposes to be insufficient in quantity. They also perceived the measurement tools as inadequate to determine establishing interdisciplinary connections and measure the course objectives.

The opinions of students regarding the physics curriculum are provided in Table 2.

Table 2
Students' Opinions on Physics Curriculum

	Opinions	$\bar{x}$	*SD*
	Learning Outcomes		
1	They improve cognitive skills.	3.76	1.05
2	They enable establishing a relationship between science, technology, society, and the environment.	2.81	1.22
3	They increase curiosity about environmental events.	3.33	1.25
4	They enable seeing the relationships between other branches of science.	2.61	1.44
5	They support creativity.	3.57	1.17
6	They enable critical thinking and inquiry.	3.42	1.19
7	They enhance problem-solving and research skills.	3.72	1.16
	Contents		
1	They suit our interests, needs, and requirements.	3.50	1.29
2	The language and expression are clear and explicit.	3.49	1.33
3	They reflect scientific knowledge.	3.94	1.07

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4	They are meaningful and learnable.	3.31	1.22
5	They are related to life and functional.	2.84	1.33
6	They reflect the latest developments in the field and are up-to-date.	3.30	1.17
7	They are interrelated and consistent.	3.63	1.13
8	They contain a lot of detail.	3.69	1.24
9	They are related to other courses and topics/are interdisciplinary.	2.69	1.39
10	They are supported with domain-specific tables, figures, diagrams, and examples.	3.48	1.23
11	They are organized in a way that facilitates learning.	3.21	1.21
12	They include examples that make students think.	3.07	1.23
13	They show how we can apply what we have learned in real life.	2.87	1.32
14	They are suitable for various teaching-learning activities.	3.53	1.29
15	They contain exercises for reviewing what has been learned.	3.31	1.19
16	They encourage understanding rather than memorization.	3.10	1.21
17	They facilitate making connections with prior knowledge.	3.45	1.16
18	They include problem situations that encourage research.	3.41	1.18
19	They arouse the desire and curiosity to learn.	3.37	1.23
20	They are compatible with the questions asked in centralized exams.	3.30	1.27
	Instructional Activities		
1	They suit the interests and needs of students.	3.45	1.46
2	They encourage student participation through various instructional activities such as discussions, question-answer sessions, and case studies.	3.44	1.37
3	They facilitate the learning process using tools and materials.	3.53	1.43
4	They progress from easy to difficult.	3.55	1.34
5	They are intriguing.	3.29	1.27
6	They include activities that are compatible with students' prior knowledge.	3.15	1.19
7	They reinforce what is learned through exercises and repetitions.	3.39	1.26
8	They include application-oriented activities (field trips, observations, and research) outside of school and the classroom.	3.34	1.34
9	They show the interdisciplinary relationship of physics with different subjects.	2.63	1.39
10	They include group work.	2.92	1.32
11	They can enhance our critical thinking skills.	3.17	1.28
12	They direct students towards research, investigation, and observation through level-appropriate activities.	3.15	1.32
13	They make lessons enjoyable and fun.	3.01	1.41
14	They enable students to apply research, homework, and project topics.	3.58	1.32
15	They contribute to physics awareness.	2.90	1.33
16	They require using supplementary books during instruction.	3.81	1.22
17	They include examples that make it easier to understand the topics.	3.46	1.24
18	They are current and interesting with the given examples.	3.20	1.26
19	They support solving questions from test books and different sources.	3.60	1.24
20	They emphasize laboratory work, providing students with opportunities to apply what they have learned.	3.26	1.31
21	They explain topics by relating them to real-life situations.	2.97	1.41
	Measurement and Evaluation		
1	The questions are consistent with the topics covered in the unit.	3.70	1.18
2	The explanations provided guide students.	2.90	1.31

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3	The questions are clear, understandable, and concise.	3.47	1.37
4	The criteria for evaluation are announced to the students.	3.10	1.20
5	The measurement tools applied are suitable for students' developmental characteristics.	3.54	1.45
6	They focus on outcomes rather than the learning process.	3.69	1.41
7	The evaluation results provide information about areas where our knowledge needs correction or addition.	3.05	1.33
8	Measurement and evaluation are conducted through out-of-class activities (e.g., research, projects, and assignments).	3.70	1.19
9	The exams are sufficient in quantity.	3.53	1.33
10	They evaluate students' projects, presentations, assignments, and research reports.	3.59	1.26
11	The administered exams can measure our higher-order thinking skills (critical thinking, creative thinking, and problem-solving).	2.96	1.32
12	Individual differences and talents are taken into consideration.	2.82	1.38
13	The questions asked are compatible with the content covered in the course.	3.68	1.27
14	Questions that are beyond the student's level are asked.	3.22	1.31
15	The questions can determine establishing connections with other courses (interdisciplinary).	2.81	1.32
16	The exams include questions that have appeared in centralized exams.	3.01	1.22

As seen in Table 2, students' opinions about the physics curriculum were moderately positive. According to students, the achievability of the learning outcomes related to a relationship between science, technology, society, and the environment, and seeing the relationship of physics with other branches of science in the curriculum, is low. Students, who found the relationship/functionality of the content with life and its relationship with other courses relatively inadequate, stated that the shortcomings in the teaching-learning process included not conducting group work, not establishing connections between other courses and real-life situations, and not developing physics awareness. Shortcomings in measurement and evaluation practices included exams not measuring higher-order thinking skills, explanations not providing guidance to students, not taking individual differences and talents into account, and questions not being unable to determine establishing connections with other courses.

Opinions Regarding the 10th Grade Electricity and Magnetism Unit of the Physics Curriculum

The findings obtained from the opinions of physics teachers and domain experts regarding the 10th grade electricity and magnetism unit of the physics curriculum are presented comparatively in Table 3.

Table 3
Opinions of Teachers and Experts Regarding the 10th-Grade Electricity and Magnetism Unit of the Physics Curriculum

Theme	Code	Teacher	Expert	Code	Teacher	Expert
	Positive Opinions	*f*	*f*	**Negative Opinions**	*f*	*f*
Learning Outcomes	Comprehensive (general) and limited	4	2	Unclear	6	5
	Focused on student behavior	3	2	Unachievable	5	5
	Compatible with student level	2	2	Inconsistent	6	3
	Clear and understandable	2	2	Limited durability and efficiency	1	5
	Comply with prerequisite knowledge	2	1	Focused on the cognitive domain	2	2
	Durable	1	2	Very comprehensive and unlimited	2	2
	Complementary to each other	-	1	Poor integrity	3	-
				Insufficient in quantity	-	2

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Theme	Code	Teacher	Expert	Code	Teacher	Expert
	Positive Opinions	*f*	*f*	**Negative Opinions**	*f*	*f*
Content	Progressive	2	1	Limited in terms of the principle of prediction	5	5
	Compatible with the principle of inclusion	2	1	Incompatible with the principle of inclusion	7	2
	Compatible with the principle of schema	1	1	Deficiencies in scientific expressions	4	5
				Incompatible with the learning outcomes	4	3
				Limited in terms of the principle of abstraction	2	5
				Limited in terms of the principle of practice	2	5
				Little association with everyday life	2	4
				Not progressive	2	3
				Does not include the affective domain	1	3
Instructional Methods and Techniques	-	-	-	Not instructive or too general expressions	10	8
Measurement and Evaluation	-	-	-	There is no explanation regarding measurement and evaluation for the unit in the curriculum.	10	8

As observed in Table 3, participants had positive opinions about the learning outcomes and content of the 10th-grade electricity and magnetism unit; however, there were more negative opinions. Participants particularly emphasized that the learning outcomes were not understandable, clear, and explicit ($f = 11$), highlighting that they were not compatible with student level ($f = 10$), followed by inconsistency ($f = 9$), and lack of durability and efficiency ($f = 6$). While some participants expressed that the learning outcomes were cognitive-oriented and very comprehensive, two teachers also emphasized that there was poor integrity between the learning outcomes and the content. For instance, one of the experts (E3) expressed his opinion as following: *"The principle of simple to complex is applied well. However, while applying the principle of simple to complex, the omission of mathematical operations in some learning outcomes restricts the understanding of the topic."* Another expert (E1) emphasized that *"the learning outcomes have a spiral structure, but what each learning outcome covers has not been clearly expressed"*, indicating that the outcomes were not clear and explicit. While a limited number of participants positively evaluated the content in terms of progressiveness and inclusion principles, other participants expressed that the content did not comply with the principles of prediction, inclusion, consistency, abstraction, goal orientation, and practice. Quotations from participants who indicated that the curriculum lacks explanations regarding instructional methods and techniques as well as measurement and evaluation dimensions are as following:

"The content and examples provided in the content mostly belong to years ago, meaning recent developments are not well-reflected. Considering the relationship of the new generation of students with technology, it will not appeal much to their interests." (E1)

"It mentions individual differences and different assessment techniques in the measurement and evaluation process. However, there is no clarity on which of these approaches should be used for physics topics." (Teacher 5)

Opinions on the Electricity and Magnetism Unit in the MoNE's 10th-Grade Physics Textbook

The findings obtained from the opinions of teachers and students regarding the Electricity and Magnetism Unit in the MoNE's Physics Textbook are presented in Table 4.

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Table 4
Opinions of Teachers and Students on the Electricity and Magnetism Unit in the MoNE's Physics Textbook

Theme	Code	Student	Teacher	Code	Student	Teacher
	Positive	*f*	*f*	Negative	*f*	*f*
Content	Comprehensive	2	2	Excessive theoretical information	4	4
	Sequential	2	2	Limited in scope	3	4
	Clear	1	-	Limited association with everyday life	1	4
	Detailed	1	-	Complicated	4	-
				Incompatible with the learning outcomes	-	4
				Not up-to-date	-	3
				No interdisciplinary associations	-	1
Activities	Subject-related experiments	2	2	Uninteresting experiments	2	2
	Photos related to everyday life	1	2	Experiments that cannot be done alone	2	1
	Learnable	-	2	Pictures and stories not related to the subject content	1	2
				Discussion topics are incompatible with the learning outcomes	-	2
				Inappropriate metaphors	-	2
Measurement and Evaluation	Geared towards centralized examination	1	1	Incompatible with the learning outcomes and content	1	6
	Compatible with student level	-	1	Complicated to understand	2	3
	Simple	1	-	More emphasis on traditional problem-solving	3	2
				Low number of questions	-	4
				Not from simple to complex	2	1
				Difficult	3	-

As seen in Table 4, some teachers and students positively evaluated the content of the electricity and magnetism unit in the textbook in terms of comprehensiveness (*f* = 4) and sequentiality (*f* = 4). Teacher 5 expressed his thoughts on the subject as following: *"The scope is good. There were many unnecessary things in previous years."* Student 9 had the following views regarding the sequentiality of the content: *"The topics are sequential, as are the examples... you cannot understand one without understanding the other."* Negative opinions on the content focused on its excessive theoretical information (*f* = 8), inadequate scope (*f* = 7), and limited association with everyday life (*f* = 5). For instance, one teacher expressed his opinion as *"...the expressions in the content are independent of each other, the examples given are very old and not up-to-date"* (Teacher 10). One student had the following remarks: *"Actually, there is information and stuff... I didn't understand; it was always theoretical. I wish it were a bit related to life"* (Student 5). Some teachers and students positively evaluated the activities in the textbook, especially for including experiments with pictures related to everyday life. However, most participants mentioned that the experiments were not interesting (*f* = 4), the experiments could not be done alone (*f* = 3), and there were pictures unrelated to the subject content (*f* = 3). For example, Teacher 2 expressed the following opinion: *"Even though years pass, the same experiments are always there. There is no room for a different experiment. These are all standard, similar ones are in middle school; I wish there were something else."* Further, Student 9 had the following view: *"For example, the pulling force of a magnet is likened to a bow in the textbook; instead, different examples could be given. Examples could be selected from different fields. For example, the electrical force in medicines."* The problems expressed in terms of the measurement and evaluation dimension included the inconsistency of questions with the learning outcomes and content (*f* = 7), their complicatedness (*f* = 5), and greater emphasis on traditional problems (*f* = 5)

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Opinions Regarding the Implementation Process of the 10th-Grade Electricity and Magnetism Unit within the Classroom

The findings obtained from teacher and student opinions regarding the teaching-learning process of the electricity and magnetism unit are presented in Table 5.

Table 5
Opinions Regarding the Teaching-Learning Process

Theme	Code	Student *f*	Teacher *f*
Content	Positive Opinions		
	Adequate in terms of scope	3	7
	Ordered from simple to complex	3	4
	Has interdisciplinary relationships	1	1
	Topics are clear and straightforward	4	-
	Learnable	3	-
	Negative Opinions		
	Minimal association with daily life	9	5
	Superficial in terms of scope	7	3
	Difficult/complicated	4	3
	Not ordered from simple to complex	5	-
	Topics are not clear and straightforward	4	-
Method and Technique	Direct instruction	8	9
	Problem-solving	5	7
	Question and answer	4	3
	Experiment with demonstration technique	3	3
	Note-taking	2	-
	Brainstorming	-	2
	Discussion	-	1
Mate-rial	Reference book	7	5
	Visual elements	2	4
Ensuring Student Partici-pation	Attracting attention	-	6
	Providing various examples	-	5
	Managing the classroom	-	5
	Associating information with everyday life	-	4
	Solving additional examples (by calling the student to the whiteboard)	-	4
	Telling scientific stories	-	3
Measurement and Evalu-ation	Oral exams, giving + or -	6	5
	Performance assignment	5	5
	Written exams consisting of open-ended questions	5	5
	Traditional problem-solving	3	3
	Multiple-choice tests	2	2
	Unit review questions in the textbook	2	2

As seen in Table 5, participants expressed positive views regarding the teaching process of the electricity and magnetism unit content. They mostly emphasized that the content is adequate in terms of scope ($f = 10$) and is

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ordered from simple to complex (*f* = 7). Students and teachers with negative views agreed that the information delivered during the class was less associated with everyday life (*f* =14), the topics were covered superficially (*f* = 10), and the topics were difficult/complicated to learn. For instance, a teacher commented: *"Electricity is a broad topic because it is only covered in the 10th grade, and there is no repetition of this topic in other grades. We have to touch upon every topic"* (Teacher 3). A student expressing his opinions about the information being presented without associating it with everyday life stated (Student 10): *"It is not often associated with everyday life. We just think of things like a light bulb directly. For example, we didn't know it from the outside, but since we saw it in our class, at least we learned its current and more."* According to the participants, the direct instruction method (*f* =17) was mostly employed during the teaching-learning process of the unit, followed by problem-solving (*f* = 12) and question and answer (*f* = 7) methods, respectively. One teacher said: *"I mean, the electricity topic is covered very intensively in terms of scope. Since the 10th grade curriculum is very dense, we have to cover it more quickly. Students experience difficulties in terms of perception. There are too many topics, and we have to cover them all"* (Teacher 3). Another teacher (Teacher 10) expressed his opinions as following: *"Physics cannot be without mathematics, so I move on to problem-solving. I usually choose problems either from my reference book. In problem-solving, I go from simple to difficult…".* Student 7 had the following remarks: *"If there is a formula, they write it first and then solve an example themselves, telling us about their style. For example, there are three question types. They show them, and we can solve the others."* On the other hand, Student 3 said: *"In our class, the teacher used to explain the topic from a reliable source before, wrote it down, and then we took notes."* As for the materials used, participants agreed that reference books (*f* =12), visual elements (*f* = 6), e.g., videos, photographs, and others, as well as textbooks (*f* = 4), were preferred. According to other findings, teachers attempted to increase students' participation in the class by attracting attention (*f* = 6), associating information with everyday life (*f*=6), solving different problems (*f* = 5) and providing additional examples (*f* = 4). For instance, Teacher 6 provided the following example: *"I pose a problem that will capture their interest, and make sure they focus on that."* Regarding the measurement and evaluation process of the unit, the participants mostly mentioned the method of conducting oral exams and giving + or - (*f* = 11). This is followed by written exams consisting of open-ended questions (*f* = 10), performance assignments (*f* =10), and traditional problem-solving (*f* = 6).

Suggestions for Improving the Electricity and Magnetism Unit

The opinions of domain experts, teachers, and students on improving the electricity and magnetism unit are summarized in Table 6.

Table 6
Opinions of Experts, Teachers, and Students on Improving the Electricity and Magnetism Unit

Theme	Code	Expert f	Teacher f	Student f
Learning Outcomes	There should be learning outcomes related to daily life.	5	7	6
	The number of learning outcomes involving mathematical operations should be increased.	3	3	1
	Enhancing thinking skills	3	1	3
	Incorporating the affective domain	3	3	-
	Being sequential	1	3	1
	Developing interdisciplinary thinking skills	1	2	-
Content	Making associations with everyday life	6	5	3
	Incorporating current examples	6	4	2
	Interrelating topics	5	3	2
	Developing higher-order thinking skills (providing different examples)	3	2	1
	Providing more elaboration	3	1	1
	Fostering interdisciplinary connections	4	-	-
	Adequate	-	-	4
	Giving more space to mathematical operations and interpretations	1	2	-

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Teaching-Learning Process	Methods and Techniques			
	Conducting experiments	6	7	6
	Problem-solving	6	4	6
	Direct instruction	4	2	5
	Case study	4	3	2
	Question and answer	4	2	-
	Demonstration	3	1	1
	Discussion	3	2	-
	Brainstorming	5	-	-
	Using metaphors	3	-	-
	Materials			
	Videos	7	3	6
	Visuals (e.g. pictures, cartoons, and more)	5	3	2
	Reading passages	3	4	2
	Using the textbook more	-	-	1
Measurement and Evaluation	Problem-solving	8	3	3
	Open-ended questions	5	4	5
	Mixed questions (e.g., multiple-choice, true-false, and fill in the blanks)	2	6	5
	Relating concepts	7	4	-
	Examining case studies	5	2	2
	Interpreting visuals	3	4	2
	Multiple-choice questions	4	2	2
	Solving problems related to everyday life	4	3	-
	Interpreting the reading passage	3	2	1
	Measuring the affective domain	4	2	-
	Filling in the blanks	2	2	-
	Project assignments	-	2	-
	Solving achievement tests	-	-	1

As indicated in Table 6, participants suggested developing the electricity and magnetism unit of the curriculum, emphasizing that the learning outcomes should be related to everyday life (*f* = 18), followed by giving more space to mathematical operations (*f* = 7), enhancing thinking skills (*f* = 7), incorporating the affective domain (*f*=6), and developing interdisciplinary thinking skills (*f* = 3). Similarly, participants emphasized associating the content with everyday life (*f* = 14), incorporating current examples (*f* = 12), and interrelating topics (*f* = 10). Other opinions regarding the content included enhancing higher-order thinking skills, providing more elaboration, fostering interdisciplinary connections, and giving more space to mathematical operations and interpretations. However, only four students indicated that the content was adequate. Below are some quotations related to these themes:

> "In the learning outcomes, examples selected from everyday life should be directly stated and aligned with the learning outcomes... Examples from the latest technology should be given. For example, high-speed trains, electric cranes, and so on. Because the latest technology should be introduced to students by associating it with everyday life." (E5)
> "Physics is the science of nature. It is necessary to make the student aware of their environment both theoretically and perceptually." (E6)
> "The topics are connected, but we present them as if they were independent. Therefore, connections should be established in the curriculum." (Teacher 17)

As seen in Table 6, conducting experiments during the teaching-learning process was recommended the most

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(*f* = 19), followed by problem-solving (*f* = 16) and direct instruction (*f* = 11), respectively. For instance, E6 had the following comments on experimental applications: *"...experiments can be conducted to make it more realistic. Additionally, experiments can be assigned as homework. Students can be asked to perform them at home. After that, students can be required to draw experiment diagrams by giving them some data."* As for suggestions regarding the use of materials in the teaching-learning process, there is a consensus on using videos (*f* = 16), visuals (*f* =10; pictures, cartoons, and more), and reading passages (*f* = 9). However, only one student indicated the need for greater use of the textbook. Half of the participants emphasized the need for problem-solving (*f* = 14) and open-ended questions (*f* = 14) in the suggestions regarding the measurement and evaluation process. Other suggested methods included mixed questions, relating concepts, case studies and interpretation, solving problems related to everyday life, interpreting reading passages, measuring the affective domain, and filling in the blanks. Some comments regarding these suggestions are as follows:

> "For example, students could be asked questions regarding a picture. For example, they could be asked questions about its connection with chemistry, biology, and economics. A classroom environment for discussion could be created on this topic." (E4)
> "It could also be an educational cartoon. It is not necessarily a funny cartoon, but a thought-provoking one. At least the child would look at it." (Teacher 7)
> "I could have used videos at the end of lessons or units. A video that serves as a review for the unit." (Student 10)

Discussion

This study examined the current state of the physics curriculum, its electricity and magnetism unit, as well as the respective textbook and classroom practices by consulting the views of teachers, students, and experts. The results indicated that there is a widespread opinion that the learning outcomes and content of the physics curriculum are not related to daily life and other disciplines, do not appeal to students' affective characteristics, and do not develop higher-order thinking skills. The descriptions of the curriculum regarding the teaching-learning process were very general and lacked specific teaching methods specific to the field, hence there is no guiding framework. Participants also agreed that the curriculum did not contain assessment tools that could reveal and develop their abilities in thinking and making interdisciplinary connections. According to these results, one could argue that the physics curriculum is designed with a disciplinary perspective, perpetuates the classical physics understanding, and does not adequately ensure relevance to current issues and daily life. Research conducted on the physics curriculum implemented in Turkey also indicates that the learning outcomes are predominantly in the cognitive domain, the content is theoretical knowledge-focused, the examples provided are not current, the teaching-learning process does not include practices that enhance science-technology-society-environment awareness, and alternative assessment tools are not indicated (Erdamar, 2019; Geçici, 2020; Tanuğur & Ogan-Bekiroğlu 2018; Yayla & Yayla, 2018). These results are similar to those reported in the international literature, where many studies have highlighted such shortcomings regarding the physics curriculum (Belo et al., 2014; Hansson et al., 2020; Vinitsky-Pinsky & Galili, 2014; Yates & Millar, 2016). These shortcomings in the physics curriculum may lead to difficulties in understanding physics subfields and their relationship with physics itself. Therefore, it is necessary to determine and structure the interaction and contexts of physics with its subfields to address these deficiencies in the physics curriculum (Campos et al., 2021; Hansson et al., 2020). Thus, by proceeding from the whole to the parts and from the parts to the whole, learning deficiencies in physics and its subfields can be addressed, leading to a more meaningful physics education. In this context, the research participants' opinions were obtained regarding the status of the electricity and magnetism unit, one of the subfields of physics, in the physics curriculum and textbook, and how teaching practices were carried out in the classroom. The results indicated that the learning outcomes related to the unit in the curriculum lacked clarity, achievability, and consistency. Besides, they mostly focused on the cognitive domain. Opinions were expressed regarding the inadequacy of the unit content in the curriculum concerning principles such as clarity, scope, scientific validity, relevance, connection to daily life, and currency. The textbook content was criticized for being narrow in scope and overloaded with theoretical information, being incompatible with the learning outcomes, and having complex language in its presentation. Participants emphasized that there was no explanation regarding teaching activities and assessment methods for the unit in the curriculum. They found the experiments in the textbook to be interesting but considered the visuals and stories to be weak and simplistic in terms of their relevance to the topic. The questions in the textbook were described as difficult to understand, incompatible with the learning outcomes and content, and based on traditional problem-solving approaches. These results are similar to those found in the relevant literature (Geçici, 2020; Kavcar et al., 2015; Li & Singh, 2016; Mbonyiryivuze et al., 2022; Yayla & Yayla, 2018). In another study, Geçici (2020) emphasized that the random ar-

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rangements made in the learning outcomes and content of the electricity and magnetism unit in physics curricula cause problems in associating topics and concepts in textbooks, deepening relationships, and understanding mathematical language and generalizations. Kavcar et al. (2015) express a similar opinion, stating that physics textbooks do not fully reflect the curriculum. According to Schubatzky et al. (2019), insufficient needs analyses conducted for teachers and students regarding electricity topics also lead to such deficiencies in the curriculum and practices.

According to Kavcar and Erdem (2017), who emphasize the importance of textbooks in guiding teachers, the negative aspects experienced within the scope of electricity and magnetism in both the physics curriculum and physics textbooks can lead to the limitation of content in the teaching-learning process and hinder comprehensive evaluations. According to Mbonyiryivuze et al. (2022), the negative views of teachers towards the curriculum and the contributions of physics textbooks to the teaching-learning process, as stated by Moore (2018), are other factors that lead to difficulties in the teaching-learning process. The results obtained from this research showed that despite significant differences between teacher and student perspectives, similar problems are experienced in the teaching process of the electricity and magnetism unit.

While teachers in this study expressed that they presented the content comprehensively during the lesson, progressing gradually from simple to complex, students disagreed. The majority of students expressed that the content was not sufficiently related to daily life. Participants agreed that direct instruction, problem-solving, and question-answer methods were more frequently used in teaching the subject. Although negative views were expressed, it was found that the main material in the class was the textbook, and visuals were not used as much as teachers perceived. Although teachers stated that they followed different methods in the teaching-learning process, students did not agree on this matter. In the measurement and evaluation process of the unit, it was found that traditional methods were mostly preferred, and efforts to develop thinking skills were not made. These results, similar to other relevant literature (Ayvacı & Devecioğlu, 2013; Cao et al., 2016; Geçici, 2020; Kavcar et al., 2015), may have stemmed from the lack of a full explanation of new learning approaches in the physics curriculum and the electricity and magnetism unit, the absence of exemplary applications, as well as the emphasis on preparing for centralized exams leading to a greater focus on solving questions in the classroom, in addition to the negative aspects expressed about the textbook. The weak teaching techniques and poor disciplinary conceptual understanding among physics teachers regarding the topic of electricity support this situation (Moodley & Gaigher, 2017). Additionally, these results also indicate that students' readiness levels, interests, abilities, competencies, and life experiences related to physics and the unit are not being considered (Henriksen et al., 2004). This situation may lead to students continuing to struggle with understanding the nature of physics and its relationship with life from a disciplinary perspective, resulting in various difficulties.

In this study, all participants emphasized the need for the learning outcomes and content in the curriculum to be more closely related to daily life and other disciplines, include current examples, enhance thinking skills, and place more emphasis on affective characteristics. They suggested incorporating teaching methods and techniques that encourage more active participation in the teaching-learning process and ensure lasting learning. Additionally, they recommended using contemporary techniques focused on higher-order thinking skills in measurement and evaluation. According to Dega et al. (2012), context-based learning approaches that incorporate everyday experiences are recommended for correcting misconceptions related to electricity and magnetism. These different learning environments should be emphasized to a greater extent. Many studies have noted that effective teaching of the subject of electricity and magnetism involves ensuring active student participation in the class, structuring the subject with an interdisciplinary understanding, relating the information to daily life, establishing different contexts, developing problem-solving skills, incorporating group learning activities, and utilizing out-of-school learning environments such as museums, science centers, and art centers (Anderson et al., 2000; Cao & Brizuela, 2016; Mbonyiryivuze et al., 2022; Moore, 2018; Nousiainen & Koponen, 2017; Sadaghiani, 2011). In assessing and evaluating the learning process and outcomes, it is recommended to include questions that measure cognitive and affective aspects, tests that measure qualitative and quantitative analysis skills, open-ended questions focusing on thinking skills, model drawing for concepts, and interdisciplinary context-based problems (Campos et al., 2021; Cao & Brizuela, 2016; Dega et al., 2012; Gunstone et al., 2008; Moore, 2018; Mbonyiryivuze et al., 2022). Therefore, it is necessary to structure electricity and magnetism in the physics curriculum and textbooks along with their nature, comprehension, and theoretical knowledge (Li & Singh, 2016), and to structure them contextually based on an interdisciplinary understanding. This situation contributes to the differentiation of understanding in physics, electricity, and magnetism, while integrating concepts and approaches into the content, thus overcoming disciplinary constraints. Consequently, in physics education, students' uniqueness is recognized, and their creative and integrative thinking skills are developed, fostering originality, fluency, sensitivity to topics, and their ability to reconstruct them (Holbrook, 2014; Manolea, 2014).

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Conclusions

These research findings generally indicate that participants agree that both the physics curriculum and the electromagnetism unit instruction program are not effective. It was determined that the classical understanding of physics persists both in the structural dimensions of the curriculum (learning outcomes, content, teaching-learning process, and assessment) and in teaching practices. They are not sufficiently associated with daily life, adapted to contemporary conditions, or up-to-date. To address all these deficiencies, there is a need to develop a curriculum based on an interdisciplinary contextual learning approach focusing on electricity and magnetism, enriching its content, and teaching it along with its various aspects. This was supported by the participants of the research, leading to the conclusion that it is indeed possible. These results indicate the need for conducting needs analyses in other subfields of physics, as well as developing and implementing curricula based on an interdisciplinary context-based learning approach. Addressing these needs may lead to structural restructuring in physics education programs and practices, thus fostering holistic, multidimensional, and interdisciplinary perspectives instead of fragmented, singular, and mono-disciplinary approaches in physics education. Thus, in physics education, students' ability to discern scientifically correct information, analyze and evaluate knowledge, develop discipline-specific literacy, generate scientific knowledge, utilize acquired skills in all aspects of life, and produce different products related to them can become more enduring, effective, and efficient.

Limitations and Implications

To address all these shortcomings, there is a need for the development of a curriculum that focuses on interdisciplinary context-based learning for electricity and magnetism, enriches the content, and teaches it along with its various aspects. This necessity was supported by the participants of the research, leading to the conclusion that it is indeed possible to achieve. The research findings are limited to the scope of the physics curriculum and the electricity and magnetism unit, the sample groups of experts, teachers, and students, as well as the characteristics of the questionnaire and interview forms used as data collection tools. In the research, questionnaires were administered to both teachers and students, while they were not administered to experts. The data obtained from the interview forms are limited to interviews conducted with eight experts, 10 teachers, and 10 students. In this regard, it is recommended to reach a larger group of experts through questionnaires and complement interviews with classroom observations. Additionally, it could be recommended to involve curriculum development experts in the process of developing/updating the physics curriculum and encourage teachers to incorporate an interdisciplinary context-based learning approach during the implementation of the curriculum.

Declaration of Interest

The authors declare no competing interest.

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