

## Physics Teachers' Views on the Content and Structure of the Physics Teaching Program

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### Abstract

The purpose of this study was to explore teachers' views about the content and structure of the 2007 Physics Teaching Program. The participants were 39 teachers working in 27 different schools in İstanbul. The study was designed as a qualitative case study. The data were collected by conducting semi-structured interviews and were analyzed by employing the constant comparative method. The data showed that 38% of the teachers held positive dispositions towards connections of content with daily life; 74% of the teachers disliked spiral sequencing of content. The teachers raised concerns about discontinuity of content between the 9th grade, in which content is superficial, and the following grades, in which content is dense. The results suggest that context based approach to presenting physics content is appreciated by the teachers, hence, continuing the emphasis on the daily life connections can be recommended. The result simplifies a necessity to differentiate the curriculum to match different student needs and to convince teachers about the necessity of multiple goals of the curriculum.

**Keywords:** Curriculum content, Curriculum structure, Science curriculum, Scientific literacy, Teacher views, Teaching programs

### Introduction

Turkey has been experiencing a comprehensive curricular reform which began in 2005 with the renewal of elementary science and technology curriculum and continued in 2008 with the renewal of the secondary science curricula, followed by a second major change in 2013. The goals of the Turkish national educational reform are aligned with international reforms (Gür, Çelik, & Özoğlu, 2012). International science education reforms, usually initiated with renewal of science curricula, are shaped by multiple goals (Ryder & Banner, 2011). One of the major goals for teaching science is to achieve scientific literacy for all citizens in order to prepare them for making informed decisions in a democratic society (OECD, 2003), which is the shared vision of both the elementary science and technology teaching program (MoNE, 2005) and the 2007 Physics Teaching Program (PTP) (MoNE, 2011). Another goal for teaching science at the secondary level is to prepare students for higher education and to develop the academic human resources of the country (MoNE, 2009).

The multiple goals for science teaching resulted in comprehensive changes in the content and structure of the secondary science curricula. The 2007 PTP explicitly makes a distinction between the 9th grade and the following grades. Because all students enroll in physics at the 9<sup>th</sup> grade, at this level physics content that individuals are likely to face throughout their lives is emphasized and is presented with contextual connections to everyday

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life. At the 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> grades the necessary physics topics are arranged within a spiral approach, connections to everyday life and conceptual understanding are emphasized where appropriate. Clearly, at the 9<sup>th</sup> grade scientific literacy and at the following grades forming a knowledge base for further education is targeted.

Looking at the historical development of physics teaching programs in Turkey, the first program was prepared in 1934. Then, respectively, in 1935, 1938, 1940, and 1985 physics curricula was prepared, however, these programs did not go beyond providing lists of topics to be taught (EARGED, 1998). In 1992, 1996, and 2005 revisions were made, however, these revisions merely involved changing the order of the topics, not a fundamental change in approach to teaching physics (Göçen & Kabaran, 2013). In 1998, The Educational Research and Development Department (EARGED) produced a draft physics teaching program that included program elements such as objectives, behaviors, activities, and assessment; but it was never implemented. In the history of the Turkish Republic, the 2007 PTP was the first teaching program that went beyond providing a list of topics (Göçen & Kabaran, 2013), which introduced fundamental changes in philosophy, aims, teaching approach, and assessment. In 2011, the 2007 PTP was revised, involving minor changes in the sequence and minor diversification of the some of the objectives, but leaving the core teaching and learning approach intact. Finally, in 2013 the most recent major curricular change happened for secondary school physics, which began to be implemented in the 2013-2014 school year.

In the 2013 PTP scientific literacy is identified as an explicit aim for teaching physics and emphasized scientific process skills; compared to the 2007 PTP where this aim was implicit and the focus was on real life connections (Göçen & Kabaran, 2013; Yiğit, 2013). On the other hand, the 2013 PTP does not endorse a specific approach to teaching physics, whereas context based teaching was the central approach in the 2007 PTP. Another major change was in the sequence, the spiraling sequencing of content was adopted in the 2007 PTP, whereas a block sequencing approach is used in the 2013 PTP (Yiğit, 2013). The number of units and objectives is also considerably reduced in the 2013 PTP as compared to the 2007 PTP. Moreover, sample activities, warnings about possible misconceptions students might have, and connections to elementary science and technology were included in the 2007 PTP, which were removed in the 2013 PTP. Finally, the volume of the curriculum was reduced from several hundred pages in 2007 to fifty pages in 2013.

The 2007 PTP is the first major change in almost 90 years of teaching physics in Turkey, therefore, it cannot be treated as an expired problem simply because it has been replaced by the 2013; it deserves close scrutiny. Learning about teachers' responses to this instance of a major curriculum shift may help policymakers and researchers understand the underlying processes of educational change and guide future curriculum development. On one hand, this understanding will extend the evidence base for decisions involving educational policy particular to the Turkish context, and on the other hand it may help policymakers and researchers all over the world to anticipate possible teacher reactions to major changes in curriculum.

The comprehensive changes in the content and structure of the 2007 PTP entails a thorough consideration of teachers' responses to these changes. Implementation of the curriculum in classrooms depends on teachers: How teachers interpret the curriculum shapes what they teach and how they teach (Van Driel, Bulte & Verloop, 2008). For the advancement of the curricular reform, understanding teachers' views about the content and structure of the curriculum is essential, however, there is a limited research base providing such information. In order to contribute to that knowledge base, the purpose of this study was to describe teachers' views about the content and structure of the 2007 PTP.

### *Theoretical Framework*

The content and structure of a curriculum can be conceptualized with a model that involves scope, sequence, continuity, articulation, and balance (Henson, 2005; Ornstein & Hunkins, 2004). The elements of this model are described and illustrated with examples from the 2007 PTP.

*Scope* refers to the breadth and depth of the content in the curriculum at any grade level. According to Goodlad and Su (1992), scope is the horizontal organization of the content. Horizontal organization refers to the arrangement of many subjects at a grade level. Scope involves decisions on which topics to include at which amount of detail. *Sequence* refers to the order of topics over time and over grade levels. Sequence is the vertical organization of the content, that is, how the topics are successively arranged over time and over the grade levels. For example, the scope of the 2007 PTP at 9th grade covers a wide range of topics: the nature of physics, matter and its properties, force and motion, energy, electricity and magnetism, and waves. The sequence of the 2007 PTP at 9th grade begins by the nature of physics and progresses to matter and its properties and to the remaining topics. In the higher grades the sequence involves introduction of new topics. For instance, at the 10<sup>th</sup> grade the modern physics, at the 11<sup>th</sup> grade stars and stellar objects, and at the 12<sup>th</sup> grade atoms and quarks are introduced. More importantly, the 2007 PTP adopted context based approach for selection of content; hence the scope of the program is heavily based on relevance to students' lives and experiences.

*Continuity* refers to the absence of disruptions or smoothness of the curriculum in the vertical dimension, or over time and over grade levels. Continuity is closely tied to sequence; it is manifested when the sequence of topics reflect the cumulative nature of the subject, without which "the resulting sequence of topics becomes nothing more than a meaningless list of items that students memorize but soon forget" (Schmidt, 2004, p.9). Continuity ensures that students will have adequate opportunities to revisit crucial concepts (Goodlad & Su, 1992). Continuity is emphasized in Bruner's (1959) notion of spiral curriculum, in which the basic concepts of a discipline are developed and redeveloped in increasing depth and breadth as the students move up the grade levels. In fact, the 2007 PTP is explicitly structured in a spiral manner. "Beginning with 9<sup>th</sup> grade and progressing to successive grades, each knowledge objective is given by deepening and expanding it from simple to complex, from easy to difficult, from concrete to abstract, from near to far" (MoNE, 2011, p. 14). The spiral structure is most evident in the titles of the learning units. For example, force and motion unit is revisited at each grade level, but at different depths. The objectives are paired with constraints, which limit the depth of the content to be covered at a particular grade. At the 9th grade students learn one dimensional motion and the constraint limits the depth with only introducing constant velocity. At 10<sup>th</sup> grade students learn Newton's laws of motion which is constrained with one dimension. At the 11<sup>th</sup> grade students learn momentum and circular motion, and at the 12th grade students learn simple harmonic motion.

*Articulation* refers to the smoothness of the curriculum in both vertical and horizontal dimensions. Vertical articulation represents the relationships among the topics or courses that appear in different grade levels. For example, the 2007 PTP specifically addresses vertical articulation by stating that it is the continuation of the science and technology course. The central concepts in physics course are designed so that they are related to the key concepts in science and technology course. Addressing vertical articulation ensures that in earlier grades students develop prerequisite knowledge for later grades. Horizontal articulation refers to the relations between different subjects in the same grade. For instance, relating concepts in 9th grade chemistry course to 9<sup>th</sup> grade physics course is an instance of horizontal articulation.

*Balance* refers to the weighing of students' individual needs and interests with the common knowledge that all the students should know (Doll, 1996). Goodlad (1963) argues that balance can be considered as establishing equilibrium between the subject matter and the learner. In the 2007 PTP balance was considered as providing the option of two levels of content. At the 9th grade level, the physics course is mandatory and knowledge that all students are expected to know are included in a limited depth at this grade level. The 10th, 11th and 12th grades are optional for students; hence for the students who are interested and want to pursue careers related to science and technology the 2007 Physics Teaching Program covers in depth physics content.

#### *Review of Teachers' Views on the Content and Structure of the 2007 Physics Teaching Program*

The 2007 PTP has been implemented for only five years; hence there are few studies that explored teachers' views about its content and structure. Although limited, this research base suggests that teachers' views about the content and structure of the 2007 PTP are diverse (Ergin, 2013). Some studies reported that in general, teachers' views towards the content of the curriculum were positive (Balta & Eryılmaz, 2011; Baybars, 2009; Ergin, Kandil-İnceç, & Şafak-Ergin, 2011). The particular issues related to teachers' views about the content and structure of the 2007 PTP were identified in subsequent studies. These studies are analyzed by deploying the theoretical framework consisting of scope, sequence, continuity, articulation and balance as elements of a curriculum.

One of the prominent issues related to scope that previous research converges is the relevance of the content in the 2007 PTP to learners' daily lives. Kapucu (2012) reported that three of the four teachers in his case study consistently identified relating physics knowledge to daily life as one of the strengths of the 2007 PTP. Similarly, descriptive surveys (Karal, 2010; Sadi & Yıldız, 2012; Şafak-Ergin, 2010) and qualitative studies (Akdeniz & Paniç, 2012; Tortop, 2012) reported that the majority of teachers recognized and appreciated the contextualization of content with an emphasis on relevance to students' everyday experiences. On the other hand, Tanuğur, Ogan-Bekiroğlu, Gürel, and Süzük (2012) found that although teachers recognized the emphasis on connections with daily life, teachers' expressed that the 2007 PTP was only partially associated with daily life, and recommended that these associations should be made more apparent. Moreover, Ayvacı (2010) found that the teachers only had a superficial understanding of the reasons for making the associations with everyday life.

Another issue related to the scope of the 2007 PTP was superficiality of the content. Kapucu (2010, 2012) reported that the physics teachers in his studies believed that the content became superficial with the 2007 PTP. According to Kapucu (2010), the teachers interpreted the changes in the content as physics becoming a verbal subject instead of a quantitative one. Akdeniz and Paniç (2012) and Sadi and Yıldız (2012) reported that the teachers expressed similar views, that they believed physics content was superficial in the 2007 PTP.

An additional issue related to the scope of the 2007 PTP that previous research converges on is the denseness of the content, or having to teach too many topics in too little time. However, it was not the new topics that teachers mainly complained, rather it was the inadequacy of class time. For example, Balta and Eryılmaz (2011) reported that only 11% of the teachers held negative views towards the newly added topics in the curriculum. Akdeniz and Paniç (2012) reported that almost half of the teachers expressed that the number of topics were too much in relation to the class hours. Similarly, Marulcu and Doğan (2010) and Sadi and Yıldız (2012) reported that almost 90% of the teachers pointed out the inadequacy of class hours to cover the topics included in the 2007 PTP.

With respect to sequence and continuity of the Physics Teaching Program, two issues stand out in previous research: the appropriateness of the sequencing of the topics and the spiral sequence. K nbet (2010) and Yolbaşı (2010) reported that about half, and S ğ t, S ğ t, and Akay (2010) and Sadi and Yıldız (2012) reported that %25 of the teachers agreed that the sequence of the content was appropriate. Akdeniz and Paniç (2012) and Kapucu (2010) also pointed out that teachers expressed concerns about the sequencing of some of the topics. Based on the available data, it is possible to assert that at least half of physics teachers are concerned about the sequence of the topics. Teachers' views about the spiraling of the topics may shed light on these concerns about the sequence. Karal (2010) and Kapucu (2010) reported that teachers did not like the spiral structure of the content in the 2007 PTP, and as a result Taşçı (2011) found that the teachers disregarded the limitations in the objectives and taught the content in a deeper level. In terms of continuity of the 2007 PTP, Karal (2010) reported that 15% of the teachers did not agree that continuity exists between the science and technology teaching program at elementary level and the 2007 PTP.

Regarding the articulation of the 2007 PTP, appropriateness of the content to students' ability level was an issue raised by teachers. However, the results reported in the previous studies diverge on teachers' views about the appropriateness of the content in students' ability level. Yolbaşı (2010) and S ğ t et al. (2010) reported that about 50%, Şafak-Ergin (2010) and Karal (2010) reported that 25%, and Akdeniz and Paniç (2012) reported that only 10% of the teachers held negative views about the appropriateness of the content to students' ability level. In contrast, Sadi and Yıldız (2012) reported that 75% of the teachers held negative views. K nbet (2010) provided an insight to the diversity of these views; among the teachers who participated in her study %30 stated that electricity and magnetism topics, 60% said topics related to waves, and 100% said that topics related to modern physics were not appropriate to students' ability level. It may be possible, that teachers think of different topics when they are asked about the appropriateness of the content to students' ability level.

One more issue raised by the teachers related to articulation of the 2007 PTP was alignment of the physics content with other science disciplines. S ğ t et. al (2010) reported that most of the physics teachers agreed with statements that indicated that the content of the 2007 PTP was parallel to other science courses. Similarly, Akdeniz and Paniç (2012) reported that only 7% of the teachers expressed negative views about the alignment of physics with other science courses. On the other hand, Şafak-Ergin (2010), Yolbaşı (2010), and Karal (2010) reported that about half of the teachers agreed on statements related to the alignment of the physics content with other science courses. In contrast, K nbet (2010) reported that 80% of the physics teachers expressed that physics content was not aligned with chemistry. Apparently, there is a diversity of agreement on the alignment of physics with other scientific disciplines.

Pertaining to the balance of the 2007 PTP, flexibility of the depth of the content for different ability levels was raised as an issue in the literature. Tortop (2012) and Karal (2010) reported that some teachers expressed that differentiated teaching programs was necessary for different types of high schools.

## **Methodology**

### *Research Design*

The qualitative case study approach (Yin, 2003), which allows an interactive process between the researchers and the participants, was adopted in this study. The case that was explored was the physics teachers' views about the content and structure of the 2007 PTP.

The University Ethics Review Board's and Istanbul National Education Administration's approval were obtained before the study began.

### Participants

39 physics teachers, working at 18 different state Anatolian high schools and 9 state general high schools during the 2010-2011 spring semester, voluntarily participated in the study. The participants were selected using maximum diversity sampling (Seidman, 2006). The characteristics of the participants are shown in Table 1.

**Table 1.** Frequency distribution of the characteristics of the study participants (N=39).

Years of experience	Anatolian High school	General High school	Total
5-10 years	3	0	3
11-15 years	8	4	12
16-20 years	8	4	12
21-25 years	5	2	7
> 25 years	1	4	5
<b>Total</b>	<b>25</b>	<b>14</b>	<b>39</b>
<b>Gender</b>			
Male	18	12	30
Female	7	2	9
<b>Total</b>	<b>25</b>	<b>14</b>	<b>39</b>

### Data Collection

The data were collected by conducting semi-structured interviews with each participant. Semi-structured interviews allow the researcher to understand how participants view and interpret the events while maintaining the focus on the topic (Merriam, 1998) because the order and exact phrasing of the questions can be altered during the course of the interview (Guba & Lincoln, 1981). The researcher and two research assistants conducted the interviews in the schools. The interviews were audio recorded and last between 15 and 60 minutes.

The questions in the interview were determined by reviewing the literature and by consulting two science education researchers interested in curriculum studies for content and coverage, which resulted in the following list of questions:

1. What do you think about the physics content in the 2007 PTP?
2. What do you think about the structure or sequence of the content in the 2007 PTP?
3. What in your view are the strengths of the content and structured of the 2007 PTP?
4. What in your view are the weaknesses of the content and structure of the 2007 PTP?
5. How do you think the problems, if any, can be resolved with the content and structure of the 2007 PTP?

### Data Analysis

The data were analyzed through the characteristic qualitative analysis processes of data reduction, data display and conclusion drawing (Miles & Huberman, 1994). The interviews were transcribed verbatim and imported into QSR NVIVO 9 to manage and organize the data as well as to keep track of the analytic progress. Data reduction proceeded with coding, which is condensing the dataset into analyzable units by creating categories (Coffey & Atkinson, 1996). Throughout the analysis constant comparative method (Glasser & Strauss, 1967) was employed, following the open coding, axial coding, and selective coding strategies (Strauss & Corbin, 1990). During the axial coding stage, the theoretical framework consisting of scope, sequence, continuity, articulation, and balance were used as the organizing themes.

*Trustworthiness*

Several strategies were used to establish trustworthiness of the study. For internal validity member checks (Lincoln & Guba, 1985) were deployed. For external validity and external reliability detailed descriptions of the research process including the research design, the participants, the data collection procedures, and the data analysis and interpretation were provided. For internal reliability convergence, agreement, and coverage among the researchers (Gee & Green, 1998) were sought. Moreover, all of the quotations were presented without any interpretation.

**Findings**

The qualitative data analysis revealed four major themes: (a) scope, (b) sequence and continuity, (c) articulation, and (d) balance properties of the content and structure of the 2007 PTP. Table 2 shows the themes and subthemes of the analysis.

**Table 2.** Frequency distribution of the teachers’ views with respect to the content and sequence themes and subthemes (N=39).

Theme	Subtheme	Anatolian High school		General High school		Total	
		f	%	f	%	f	%
Scope	Relating physics topics with everyday life is positive	11	44	4	29	15	38
	9 <sup>th</sup> grade became the introduction of physics, it is positive that the focus is on concepts rather than mathematical operations	2	8	3	21	5	13
	9 <sup>th</sup> grade physics content became superficial, it is negative, it undermines further physics learning	20	80	9	64	29	74
	The content is dense at grades 10 through 12	20	80	9	64	29	74
Sequence and continuity	Spiral structure is positive	5	20	1	7	6	15
	Spiral structure is negative	20	80	9	64	29	74
	The content sequence is disconnected	20	80	9	64	29	74
	We cover the content in greater depth than suggested in the curriculum	15	60	5	36	20	51
Articulation	The content is above students’ ability level at grades 10 through 12	8	32	4	29	12	31
	The elementary science and technology teaching program cannot prepare students for secondary physics courses	7	28	1	7	8	21
Balance	The physics teaching program should be differentiated with respect to school type	7	28	1	7	8	21

*Teachers’ views about the scope*

With respect to the scope, 38% of the teachers stated that the emphasis on relating physics topics to everyday life is a positive aspect of the 2007 PTP. More teachers working at Anatolian High schools than teachers working at General High schools acknowledged the importance of relating physics content to daily life. According to these teachers, teaching physics in the context of everyday life attracted students’ interest, as illustrated with the following quote (the numbers in parentheses identify the participant teacher):

*I think the best part of the curriculum is that it shows connections to everyday life. For example, at 11th grade we are teaching waves. Real world applications of sound waves are given in the curriculum. We teach about ultrasound, how an unborn child's image is formed using sound waves. We teach sonar devices which are used to detect positions of submarines and fish. We teach how sound waves are used to break down kidney stones. With these connections physics topics come to life, they become real. This attracts students' interest and they develop general culture (2006).*

While talking about the relevance of physics topics to everyday life, the teachers did not differentiate among the grade levels. In contrast, while the teachers were talking about the details of the content, they made a clear distinction between the 9th grade and the following grades. According to the teachers, 9th grade content is woven around several central topics and the emphasis has shifted from mathematical operations to conceptual understanding. This shift in emphasis was interpreted from two opposite sides. A minority of the teachers (13%) expressed that conceptual focus transformed 9th grade physics an introduction to physics and attracted students' interest. For example, a teacher stated:

*The 9<sup>th</sup> grade topics are more conceptual now. Before this curriculum it was based heavily on problem solving and mathematical operations. It was all about asking difficult problems and most of the students could not do those. The teacher solved the problem and the students understood nothing. Now we are only interested in the concepts, not the problems. We ask questions and discuss the answers together. With this new focus the students are more interested in physics. Students also feel that they can do physics, before perhaps %10 of the students learned what we taught, now it is definitely more (1051).*

In contrast, the majority of the teachers (74%) stated that such shift turned 9th grade physics into a superficial body of knowledge and undermined further learning of physics. The negative attitude towards the shift of emphasis from mathematical operations to conceptual understanding was more evident for the teachers working at Anatolian High schools. According to these teachers, the abrupt change in the depth of content and mathematics involved was experienced as a shock akin to hitting a wall. For example, a teacher said:

*The curriculum at 9<sup>th</sup> grade is designed for both verbal and quantitative aptitude students. They want all students to develop a general culture about physics so they made it very superficial. In the curriculum the real physics start at the 10th grade. But I think this is completely wrong. Because you have to begin building a foundation early on in 9th grade so the students can be comfortable with topics in the following grades. Because the students learn so little physics in 9<sup>th</sup> grade, when they face the real physics in 10th grade they say "we thought that physics was easy, where did these difficult mathematics come from?" They have a very difficult time understanding physics after 9th grade. They basically hit the wall (2028).*

Related to the scope of the 2007 PTP, when the teachers were talking about 10th and the following grades, a common issue they raised was the denseness of content. By denseness of content the teachers referred to the ratio of the number of topics they have to teach to the class time they have. The teachers stated that the scope of the physics content in 10th grade and after was deeper, more technical, and more quantitative. Teaching at this depth of content required more class time, which the teachers did not have. The teachers suggested that either



the number of topics should be reduced or the class hours for physics per week should be increased. For example, a teacher said:

*There are too many topics in 10<sup>th</sup> grade and following grades. These topics mostly are very detailed and involve solving problems. If we teach them all in the deepness asked from us, the time falls short. So either the class hours should be increased or the number of topics should be decreased (2042).*

*Teachers' views about the sequence and continuity*

In the analysis the sequence (ordering of content) and continuity (the smoothness of sequencing content) were grouped together, because the teachers' views about these aspects were focused on the spiral organization of the 2007 PTP. The teachers clearly recognized the changes in sequencing of content. According to the teachers, the 2007 PTP adopted a spiral approach in sequencing the content in which a topic is spread through the years and is revisited at every grade level, instead of block sequencing in which a topic is presented once from beginning to the end. The spiral sequencing of physics content was interpreted by the teachers from two opposite directions. A minority of the teachers (15%) stated that beginning to teach a topic at the 9<sup>th</sup> grade and then building up on that topic in the subsequent grades was constructive because such sequencing allowed the students to revisit and remember the concepts related to that topic. According to these teachers, spiral sequencing helped students learn the content at a deeper level as they pass to the next grade. For example, a teacher stated:

*My view on the spiraling approach is positive. We continue the same topics in successive years and refresh students' knowledge. When we taught a topic at 9<sup>th</sup> grade and not talk about it at all in the following years, the students forgot almost everything about that topic. Now, they learn the basics about waves in 9th grade, then they learn about water waves in 10th grade, then about sound waves in 11<sup>th</sup> grade, and finally about electromagnetic waves in 12<sup>th</sup> grade. So every year they have a chance to review what they learned about waves in the previous years (1047).*

In contrast, the majority of the teachers (80%) considered the spiral structuring of the physics content as a significant annoyance. According to these teachers, the spiral sequencing of the topics did not enhance the connections between topics; to the contrary it resulted in fragmentation of the concepts and caused a disruption of flow. These teachers suggested that physics content should be sequenced in a block structure; a topic should be taught from the beginning to the end in a single grade level. The following teachers' statement illustrates this suggestion:

*The topics are very disconnected. You can't teach physics in this fragmented manner. If you are going to teach electricity, give all of it, if it is mechanics teach all of the concepts in it (1001).*

According to these teachers, because of the spiral sequence they had to teach every topic from the beginning at each grade level, which they saw as a waste of time. For example, a teacher said:

*In the new curriculum the topics are fragmented. All the topics are shattered into pieces. You begin to teach a topic and you come to a certain point and you have to stop. Then out of curiosity the students ask about the rest of the topic. So every year, we begin from scratch. This is a waste of time. With the spiral structure we teach everything from the beginning at each grade (1029).*

About half of the teachers stated that they taught physics topics in greater detail than it was required in the official curriculum. According to these teachers, the major reason for teaching every topic in greater detail, in many cases in its entirety, was that they felt their students would be disadvantaged if they followed the constraints. These teachers stated that they had to take into account the other schools, private courses, tutors, and external books beside the official curriculum. According to these teachers, their students were going to take the university entrance exams, and the teachers felt they had to teach everything that can be included in the exam items. For example, a teacher said:

*The curriculum tells me to stop at a certain point in a topic at 9<sup>th</sup> grade. But our colleagues at other schools and private courses put us into a difficult situation. For instance, at 10<sup>th</sup> grade we are required to teach Ohm's Law, but I see that the students are learning electrical motors in the private courses. They bring me questions about electrical motors, so I teach that too. It is not like let's read the book from where we left last year. I have to start all over again and go all the way to the end every year. The lines that delineate where to stop in the topics is not understood the same way by everyone, so to be on the safe side we teach in greater detail (1047).*

#### *Teachers' views about the articulation*

The difference between the 9<sup>th</sup> and the following grades in terms of content of the curriculum was also evident in the teachers' views about the articulation aspect of the 2007 PTP. Regarding articulation, about one third of the teachers stated that the content included in the 2007 PTP for grades 10 through 12 is above students' ability level. The teachers' major concern was that some topics were too abstract for students to comprehend. For example, a teacher said:

*My students did not understand Einstein's physics at all. They just cannot make sense out of how time can be different (in different reference frames). They can't understand how light's speed can be constant. They think of it in terms of ordinary speed addition, if you drive towards the light source its speed must increase and if you drive away from it its speed must decrease. Then we say that it is the light speed which is constant, not the time. Then it becomes a piece of information the students simply memorize. We are teaching this to 15-16 year olds in 10<sup>th</sup> grade. We show it mathematically but I don't think they can actually imagine that time flows slower if you are going fast. We then give examples that time seems to speed up, like when you are having a good time. But then they think of time as a subjective thing, not the objective entity we speak of in physics (1044).*

An additional issue related to the articulation of the 2007 PTP was the alignment of the program with the elementary science and technology teaching program. About 20% of the teachers stated that there is a misalignment of the elementary science and technology teaching program and the 2007 PTP. The teachers' criticisms were not about the misalignment of the content; rather these criticisms were directed towards cognitive skills such as problem solving. These teachers expressed that elementary science and technology courses were inadequate for preparing the students for secondary physics courses. For example, a teacher stated:

*The students do not learn science in elementary school. You want them to think about something but they are not used to thinking. They want you to give them the correct answers. They cannot answer the questions after we finish a unit. They can solve a problem only if you ask exactly the same*

*problem you solved in class. If you change the problem even a little they cannot do it (1019).*

#### *Teachers' views about the balance*

Concerning the balance of the 2007 PTP, the teachers stated that the program was not serving the needs of all students. These concerns were raised mostly by the teachers working in Anatolian High schools; their argument was that it is neither possible nor fair to implement the 2007 PTP the same way in different types of schools. According to these teachers, the 2007 PTP was too difficult for the students in vocational high schools and it was too easy for the students in Anatolian and science high schools. The solution that these teachers offered was to separate the teaching programs with respect to school type. About 20% of the teachers stated that different teaching programs should be prepared for different types of high schools. For example, a teacher expressed:

*The main problem with the teaching program is it is required to be taught in all kinds of schools. In an Anatolian high school the students are capable and you can teach these topics at a level deeper than it is required. But I worked in a vocational school before I came here. The students in the vocational school and even in general high schools are very different. You cannot teach physics the same way to those students as you teach to those in an Anatolian High school. But they say you must implement the same curriculum in all of these different schools (1025).*

#### **Discussion**

The purpose of this study was to explore views of teachers about the content and structure of the 2007 PTP. The teachers' views were analyzed with respect to scope, sequence and continuity, articulation, and balance of the content. In terms of scope, about 40% of the teachers identified relating physics topics with everyday life as an important merit of the 2007 PTP. This result corroborates previous research findings (Akdeniz & Paniç, 2012; Karal, 2010; Sadi & Yıldız, 2012; Şafak-Ergin, 2010; Tortop, 2012) and support the idea that context based approach to physics content is appreciated by the teachers. Although there may be issues with the depth of teachers' understanding of the reasons for adopting a context based approach (Ayvaci, 2010; Tanuğur et al., 2012), it may still be constructive to continue context based approach to physics content in future teaching programs. In the 2013 PTP, context based approach is not explicitly emphasized anymore, which appears to be a counter-intuitive move, given that connections to daily life could have been used as leverage as it perhaps was the best aspect of the 2007 PTP in teachers' eyes.

A minority of the teachers stated that the shift of emphasis in the scope of physics content from a mathematical to a conceptual focus was a positive advance. However, this positive interpretation was not shared by most of the teachers. The majority of the teachers interpreted the shift from mathematical operations to concepts as a move which made physics content superficial. The teachers' perceptions of physics becoming a verbal subject instead of a quantitative subject resonate with the results from previous research (Akdeniz & Paniç, 2012; Kapucu, 2010; Sadi & Yıldız, 2012). In the 2013 PTP, based on scientific literacy argument, the technical and mathematical side of physics is kept to a minimum not only in 9th but also 10th grade. This insistence on scientific literacy may help convince teachers that this change in focus is not a fad that will fade away in a few years, but an enduring policy change.

The majority of the teachers in this study raised concerns about the denseness of content and the inadequacy of class time for teaching the prescribed amount of topics in the 2007 PTP, which is a result aligned with previous studies (Akdeniz & Paniç, 2012; Marulcu &

Doğan, 2010; Sadi & Yıldız, 2012). Moreover, the results of this study also show that denseness may not be perceived the same way by the teachers for all grade levels. The teachers made a clear distinction between the 9th grade and the following grades; they specifically referred to 10th grade and the following grades when they elaborated on the denseness of the content. The perception of having to teach too many topics in too little time was particularly evident in grades 10 through 12. In the 2013 PTP, the number of units and objectives were reduced, particularly in 9th and 10th grades, which may help mend the persistent complaints about the inadequacy of class time for physics. However, in the 11<sup>th</sup> and 12<sup>th</sup> grades the objectives are more technical which may require spending more time as compared to objectives in the prior grades. Teachers' responses to the 2013 PTP after they begin teaching 11<sup>th</sup> grade will be important, which will be in 2015-2016 school year, for understanding whether the amount of content included in these grades helped thin the perceived denseness of the content.

With respect to sequence and continuity of the 2007 PTP, only a minority of the teachers held positive views towards the appropriateness of the sequence and the spiral structure of the program. The majority of the teachers (74%) did not approve the ordering of the topics and were particularly very disconcerted with the spiral structure, which is a finding that aligns with the results reported by Söğüt et al. (2010) and Sadi and Yıldız (2012). About half of the teachers expressed that they ignored the constraints and taught the content at a greater level of detail than required by the curriculum; a result that overlaps with the findings reported by Karal (2010), Kapucu (2010), and Taşçı (2011). This result reinforces the idea that physics teachers did not like the spiral sequence in the 2007 PTP. Perhaps, one of the most appropriate decisions made in the 2013 PTP was stepping back from spiral sequencing, when viewed through the results of this study.

In terms of the articulation of the 2007 PTP, one third of the teachers in this study raised concerns about the appropriateness of the content to students' ability level. In previous research the percentage of teachers sharing the concern about appropriateness of content to students' abilities was between 10% and 75% (Akdeniz & Paniç, 2012; Karal, 2010; Sadi & Yıldız, 2012; Şafak-Ergin, 2010; Yolbaşı, 2010). One explanation of this diversity was that teachers' views about appropriateness to students' abilities is related to particular topics, as shown by Künbet (2010). The results of this study demonstrate that the teachers made a clear distinction between the 9th grade and the following grades in terms of appropriateness of content to students' abilities. Hence, another explanation for the diversity of teachers' views about appropriateness of content to students' abilities may be that teachers' views not only are related to the topic but also to the grade level. Whether teachers' concerns about the appropriateness of content were considered in the 2013 PTP remains a topic for further investigation.

Moreover, 20% of the teachers in this study expressed that elementary science and technology courses cannot adequately prepare students for physics courses in high school. Karal (2010) reported comparable results regarding the teachers views on continuity of the elementary science courses and secondary physics courses, however, it was not clear what the teachers were exactly concerned about. The results of this study expand the knowledge on the teachers' views about the continuity of elementary science and secondary physics courses. The teachers were not concerned with the content continuity, but were concerned about the cognitive skills particularly problem solving skills of the students. Although this result does not necessarily imply a problem with the content continuity of science curricula in elementary and secondary levels, it points out the need to focus on higher level cognitive skills such as problem solving early on.

Previous research indicates that there is a diversity of views with respect to the horizontal alignment of physics with other science disciplines. Some studies (Akdeniz & Paniç, 2012; Söğüt et al., 2010) reported that most of the teachers do not view alignment with other science disciplines as an issue. In contrast, other researchers (Karal, 2010; Şafak-Ergin, 2010; Yolbaşı, 2010) reported that at least half of the teachers had concerns about horizontal alignment. For example, Künbet (2010) reported that 80% of the teachers did not think that physics curriculum was aligned with chemistry. The teachers in this study did not explicitly raise concerns about horizontal alignment of physics and other science disciplines, which is a result in line with the results reported by Akdeniz and Paniç (2012) and Söğüt et al. (2010). Teachers' views about the horizontal alignment of physics with other science disciplines remain to be explored by further research.

In terms of the balance of the 2007 PTP, previous research pointed that some teachers are concerned about the flexibility of the depth of the content with respect to different ability levels. The results of this study support the findings of Tortop (2012) and Karal (2010), that some teachers think that the physics curriculum requires differentiation with respect to different types of high schools. About 20% of the teachers in this study pointed the need for different teaching programs for different types of high schools.

When viewed collectively, the results of this study show that the teachers perceived a deep gap between the content of the 9th grade and the following grades in the 2007 PTP. The teachers appear to have recognized the different goals for teaching physics at the 9th grade in which the goal is scientific literacy, and the following grades in which the goal is preparing students for higher education. However, the teachers do not seem to approve such difference in goals. Especially the teachers working at Anatolian high schools expressed that the difference in goals resulted in a disconcerting discontinuity of content. According to these teachers, such gap in content between grade levels undermined further physics learning, that their students experienced a shock and felt physics was not easy when they met the technical side of physics at the 10th grade. As a solution, some of the teachers suggested differentiating the curriculum for different types of high schools.

In 2007 PTP the content of 9th grade was geared towards scientific literacy, with the 2013 PTP, scientific literacy aim was extended to 9th and 10th grades. In the 2013 PTP, the content in 11th and 12th grades is more technical and mathematical, even more so than the 2007 PTP. It can be predicted from the results of this study that teachers will point out the gap in the depth of content in the 2013 PTP as they start teaching 11th grade, which will be 2015-2016 school year. Apparently, the push towards scientific literacy is continuing, and teachers have been introduced to it in practice for about 7 years, however, it is likely that the majority of them still will not approve the dual goals of scientific literacy and higher education preparation. The curriculum was not differentiated for academically selective schools as of 2015; hence, the policymakers seem to have not answered to this need yet.

These results imply that teachers need to be informed about the necessity of multiple goals for the curriculum. The results also imply that providing alternative teaching programs for physics may help teachers develop more positive dispositions towards the curriculum. A regular teaching program suitable for general high schools and an advanced teaching program suitable for Anatolian and science high schools may serve different student needs better.

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