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Prospective Physics Teachers' Views on Their Knowledge about the New Concepts in Turkish High School Physics Curricula

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Abstract
The purpose of this study was to a) investigate prospective physics teachers' views on their knowledge about new physics concepts introduced in Turkish High School Physics Curricula; b) investigate the sources of their acquired knowledge about these new physics concepts; and c) explore if there were differences in views on knowledge about these new physics concepts among prospective physics teachers of different genders, years of study and universities. A total of 98 prospective physics teachers from different two universities in the physics and physics education departments participated in this study. "Physics Concepts Knowledge Questionnaire" developed by the authors was administered to the participants. Descriptive statistics and *t*-test were used to analyze the data collected. No statistically significant difference was found in mean view scores of prospective physics teachers of different genders, in different years of study, and from different universities. Additionally, more than 50% of prospective physics teachers thought that they were not knowledgeable about 19 of the 32 concepts selected for this study. The results of this study also showed that prospective physics teachers did not consider themselves as knowledgeable enough especially about astronomy and sound concepts.
Key words: Physics Education, Turkish High School Physics Curricula, Prospective Physics Teachers, Physics Concepts

Introduction

In Turkey, teachers have implemented new Turkish High School Physics Curricula (THSPC, 2007) since 2008. The content and structure of them are different from previous ones. Old ones only included titles of subjects and they were deficient in the explanation of how the lessons were conducted (THSPC, 2007). However, new physics curricula emphasize the teaching and learning approaches making students mentally and physically active, development of students' problem solving, creative and critical thinking skills and relation of physics with daily life.

In addition to these changes, new concepts were added to new physics curricula. In this regard, expecting in-service and pre-service teachers to have developed a deep understanding of physics concepts that they will be required to teach is logical. Physics Teacher Subject Matter Competencies (PTSMC, 2011) also emphasizes the necessity of being knowledge about physics concepts.

Importance of teachers' knowledge for effective teaching was discussed by some researchers (Buchmann, 1984; Shulman 1986, 1987). For example, Buchmann (1984) claims that being knowledgeable about the content is prerequisite for the teaching of the activities.

According to him, activities used in class hang altogether in the air without teachers' content knowledge. In addition, Shulman (1987) emphasized "scholarship in content discipline" (p.8) for effective teaching. Teachers should be knowledgeable about content areas. For example, an English Teacher should know grammar, and language use (Shulman, 1987).

Shulman (1986) also categorized teachers' content knowledge into three parts: subject matter content knowledge, pedagogical content knowledge, and curricular knowledge. Shulman (1986) defined content knowledge as "amount and organization of knowledge per se in the mind of teacher" (p. 9). Content knowledge includes knowledge of facts and concepts (Shulman, 1986). Content knowledge of teachers plays an important role in delivery of information. If teachers do not know the thing that they transfer, delivery skills—pedagogy in general sense—are fruitless (Buchmann, 1984). There can be some problems in teachers' pedagogy, when teachers feel unconfident in their content knowledge (Donovan & Bransword, 2005). For example, although teachers might know how to teach subjects, lack of content knowledge affects their instruction negatively. Teachers who do not describe and display anything are not successful in answering questions coming from students (Buchmann, 1984).

As a result, teachers with insufficient content knowledge are likely to make mistakes when teaching subjects, thereby causing problems in student learning (Ball & McDiarmid, 1989; Çekbaş & Kara, 2009; Kahyaoğlu & Yavuzer, 2004). Teachers having a proper understanding of content knowledge, on the other hand, know how to teach subjects and implement his/her lesson according to this (Kahyaoğlu & Yavuzer, 2004). In addition, not having enough content knowledge can cause students to learn concepts incorrectly (Ball & McDiarmid, 1989).

Some studies have been conducted to investigate teachers' knowledge level about the physics concepts until now. Ünsal, Güneş and Ergin (2001) investigated undergraduate students' knowledge level about the features of earth, moon and sun. Results of this study showed that many of the students had wrong and insufficient information about the astronomy concepts. Kahyaoğlu and Yavuzer (2004) explored elementary prospective teachers' knowledge level about science concepts. They found that prospective teachers did not have required knowledge to teach science effectively.

Galili and Lehavi (2006) investigated experienced high school physics teachers' ability to define 11 fundamental physics concepts and their views about the importance of concept definition. Fundamental concepts of mechanic, thermodynamic and electricity were explored in this study. Although teachers believed in the necessity of defining concepts in the classroom, they had low ability to define physics concepts operationally. They argued that university students should be reinforced for concept definition in university education.

Çekbaş and Kara (2009) investigated prospective elementary science teachers' knowledge level about physics concepts by administering an achievement test. They found that participants did not have enough physics knowledge especially in the topics 'Newton Laws', 'Curricular Motion' and 'Power'. In addition, students' achievement level scores decreased when the year of study level increased.

Additionally, some studies related to Turkish High School Physics Curricula that were put into practice in 2008 were conducted. For example, Balta and Eryılmaz (2011) investigated physics teachers' views about changes in the new physics curriculum and needs for in-service training about new topics in the physics curriculum. They claimed that teachers needed more in-service training about some of the new topics such as adhesion-cohesion, plasma state of water and earthquake waves.

Ergin, Şafak and İngenç (2011) investigated physics teachers' views about new physics curriculum. They administered a questionnaire to 41 physics teachers. The questionnaire aimed to measure teachers' views about objectives in the curriculum, content of the curriculum, teaching and learning activities and measurement and evaluation activities in the curriculum. They found that physics teachers had generally positive views about objectives in the curriculum, and content of the curriculum. For example, many of the participants thought that objectives in the curriculum were understandable and they were appropriate to students' level. However, teachers had partially positive views about suggested teaching and learning methods and measurement and evaluation activities in the curriculum. For example, many of the participants thought that lesson hours were not enough to implement curriculum by considering suggested teaching and learning methods and measurement and evaluation activities.

Baybars and Kocakülah (2010) examined 44 physics teachers' views about Grade 9 Turkish High School Physics Curriculum. They found that majority of the participants thought that the approaches in the curriculum were clearly defined. In addition, many of them did not believe the applicability of the suggested instructional methods in the curriculum. They indicated that physical facilities of the school were not appropriate and lessons hours were limited to implement new physics curriculum.

The studies (Çekbaş & Kara, 2009; Kahyaoğlu & Yavuzer, 2004; Galili & Lehavi; 2006) conducted until now measured prospective or in-service teachers' knowledge level about fundamental concepts related to physics or science. Ünsal, Güneş and Ergin (2001) explored only the concepts related to astronomy. Balta and Eryılmaz (2011) investigated physics teachers' views about the necessity of in-service training about some of the physics concepts. In addition to them, physics teachers' views about the content of the physics curriculum were explored (Baybars & Kocakülah, 2010; Ergin et. al, 2011).

However, current prospective physics teachers in universities may not be familiar with the newly introduced physics concepts due to changes in Turkish High School Physics Curricula. While practicing teachers may need additional in-service training and/or personal study to overcome their unfamiliarity with these concepts and how to teach them, prospective teachers still have the opportunity to close this gap before they graduate to become physics teachers. In fact, it is quite reasonable to expect new graduates from physics education programmes of secondary science and mathematics education departments to be knowledgeable about these newly introduced physics concepts. However, emphasis given, if any, to conceptual learning during university education is debatable. Prospective teachers may graduate with an insufficient knowledge about new physics concepts due to low emphasis on teaching and learning of these concepts. Therefore, there is a need to determine prospective physics teachers' views on their knowledge about, particularly the newly introduced, concepts from the high school physics curricula. Hence, it is our purpose in this study to a) investigate prospective physics teachers' views on their knowledge about the new physics concepts introduced in Turkish High School Physics Curricula; b) investigate the sources of their acquired knowledge about these new physics concepts; and c) explore if there were differences in views on knowledge about these new physics concepts among prospective physics teachers of different genders, years of study and universities.

Method

Research Questions

The main concern for this study is to find out prospective physics teachers' views on their knowledge about new physics concepts introduced in Turkish High School Physics Curricula. The research questions focused on in this study are as follows:

1. What are the prospective physics teachers' views on their knowledge about the new physics concepts introduced in Turkish High School Physics Curricula?
2. What are the sources of prospective physics teachers' acquired knowledge about the new physics concepts introduced in Turkish High School Physics Curricula?
3. Is there a difference in prospective physics teachers' views on knowledge about the new physics concepts introduced in Turkish High School Physics Curricula according to different genders?
4. Is there a difference in prospective physics teachers' views on knowledge about the new physics concepts introduced in Turkish High School Physics Curricula according to different years of study?
5. Is there a difference in prospective physics teachers' views on knowledge about the new physics concepts introduced in Turkish High School Physics Curricula according to different universities?

Sample

A total of 98 4^{th} and 5^{th} year physics and physics education students from two universities participated in this study in the fall semester of 2009-2010 academic-year. Of these 98, 52 were female and 46 were male. Physics students (N=14) were also included in this study because they take same courses (i.e., physics courses from the department of physics) with physics education students and they are able to become physics teachers after completing a teacher certification programme. Physics students and physics education students are considered, and therefore referred to, as prospective physics teachers in this study.

Instrument and Data Collection Procedure

Turkish High School Physics Curricula were examined in detail to select concepts before preparing a questionnaire. In selecting the concepts to be included in the study, physics concepts in the physics curricula were classified first as 'new' or 'existing'. While new concepts refer to those concepts which were either not taught at all or taught but at a superficial level before the new physics curricula were implemented, existing concepts refer to concepts which were taught to students even before the new physics curricula were implemented. Upon close examination of Turkish High School Physics Curricula, 32 concepts, which were thought as 'new', were selected to include in the questionnaire. These selected concepts were expressed clearly in the "scientific concepts to be learned" and "student objectives" parts of Turkish High School Physics Curricula.

From the concepts selected, a four point Likert-type "Physics Concepts View Questionnaire" (see Appendix) was developed by the authors to collect data. It consisted of four alternatives, placed next to each concept: "I have never seen the concept before;" "I saw the concept before but I have no knowledge about the concept;" "I have little knowledge about the concept;" and "I know enough about the concept". In addition, prospective physics

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teachers were asked to indicate where they saw/learned the concept (for example; book, scientific journals, television, course etc.), if they had chosen the alternatives “I have little knowledge about the concept” and “I know enough about the concept”.

Two experts examined the questionnaire for whether the questionnaire actually included new concepts. After taking their agreement about the concepts to be measured, questionnaire was administered to participants in two universities. This study was a cross sectional-descriptive study according to the research purpose and time dimension (Johnson, 2001). The data were collected from the participants at a single point in time.

Data Analyses

Descriptive statistics and *t*-test were used to analyze the data. For the sake of simplicity of analyses, first two alternatives—“I have never seen the concept before” and “I saw the concept before but I have no knowledge about the concept”—were combined, as “I have no knowledge about the concept”. In addition, “I have no knowledge about the concept” was coded as ‘1’, “I have little knowledge about the concept” was coded as ‘2’, and ‘I know enough about the concept’ was coded as ‘3’ in the SPSS.

Results

To be able to answer research question 1, mean view scores of respondents were calculated for all prospective physics teachers.

Descriptive statistics for all participants

The results of descriptive statistics indicated that over 50% of the participants thought that they were not knowledgeable about the following concepts: ‘parallax’, ‘parsec’, ‘light pressure’, ‘Rayleigh criterion’, ‘biomagnetizm’, ‘angular magnification’, ‘liquid crystals’, ‘infrasonic’, ‘supersonic’, ‘shock wave’, ‘sonic boom’, ‘absolute brightness’, ‘black and white dwarfs’, ‘neutron star’, ‘adhesion’, ‘cohesion’, ‘binary star’, ‘quasar’, and ‘cosmic microwave background radiation’. Participants’ mean view scores (X), standard deviation of means view scores (sd), frequencies of participants’ responses to alternatives (f) and percentage values for alternatives (%) were shown in Table 1.

As shown in Table 1, all participants think that they have no knowledge about the concepts ‘parallax’, and ‘parsec’. In addition, 99% of participants think that they have no knowledge about the concepts ‘quasar’ and ‘binary star’. When the first ten concepts are examined in Table 2, eight of them are astronomy concepts and two of them are sound concepts. Over 90% of prospective physics teachers think that they have no knowledgeable about concepts ‘infrasonic’ and ‘sonic boom’. They do not think themselves as knowledgeable about the concepts related to astronomy and sound. Moreover, over 50% of prospective physics teachers think that they have little knowledge or enough knowledge about the concepts ‘quark’, ‘lepton’, ‘hadron’, ‘baryon’ and ‘meson’. They think that they are more knowledgeable about the concepts related to subatomic particles than concepts related to astronomy and sound.

Table 1. Descriptive statistics for individual concepts

About the concept of ...	I have no knowledge		I have little knowledge		I know enough	
	f	%	f	%	f	%
Parallax (X=1,00, sd=.000)	98	100,0	0	0,0	0	0,0
Parsec (X=1,00, sd=.000)	98	100,0	0	0,0	0	0,0
Quasars (X=1,01, sd=.101)	97	99,0	1	1,0	0	0,0
Binary Star (X=1,01, sd=.101)	97	99,0	1	1,0	0	0,0
Infrasonic (X=1,04, sd=,245)	95	96,9	2	2,0	1	1,0
Absolute Brightness (X=1,05, sd=,300)	95	96,9	1	1,0	2	2,0
Cosmic Microwave Background Radiation (X=1,05, sd=,300)	95	96,9	1	1,0	2	2,0
Neutron Star (X=1,06, sd=,315)	94	95,9	2	2,0	2	2,0
Sonic Boom (X=1,07, sd=,296)	92	93,9	5	5,1	1	1,0
Black and White Dwarfs (X=1,07, sd=,329)	93	94,9	3	3,1	2	2,0
Biomagnetizm (X=1,13, sd=,370)	86	87,8	11	11,2	1	1,0
Light Pressure (X=1,14, sd=,431)	87	88,8	8	8,2	3	3,1
Shock Wave (X=1,17, sd=,431)	83	84,7	13	13,3	2	2,0
Angular Magnification (X=1,26, sd=,509)	75	76,5	20	20,4	3	3,1
Supersonic (X=1,29, sd=,592)	77	78,6	14	14,3	7	7,1
Liquid Crystals (X=1,33, sd=,605)	73	74,5	18	18,4	7	7,1
Rayleigh Criterion (X=1,37, sd=,679)	73	74,5	14	14,3	11	11,2
Adhesion (X=1,64, sd=,777)	53	54,1	27	27,6	18	18,4
Beat frequency (X=1,65, sd=,719)	48	49,0	36	36,7	14	14,3
Cohesion (X=1,67, sd=,770)	50	51,0	30	30,6	18	18,4
Lepton (X=1,74, sd=,764)	44	44,9	35	35,7	19	19,4
Beat (X=1,76, sd=,733)	41	41,8	40	40,8	17	17,3
Hadron (X=1,77, sd=,771)	43	43,9	35	35,7	20	20,4
Electric Permittivity (X=1,77, sd=,783)	44	44,9	33	33,7	21	21,4
Baryon (X=1,78, sd=,793)	44	44,9	32	32,7	22	22,4
Meson (X=1,84, sd=,808)	41	41,8	32	32,7	25	25,5
Capillarity (X=1,85, sd=,765)	37	37,8	39	39,8	22	22,4
Quark (X=1,95, sd=,751)	30	30,6	43	43,9	25	25,5
Inertial Reference System (X=2,05, sd=,751)	25	25,5	43	43,9	30	30,6
Surface Tension (X=2,20, sd=,673)	14	14,3	50	51,0	34	34,7
Harmonics (X=2,31, sd=,709)	14	14,3	40	40,8	44	44,9
de Broglie Hypothesis (X=2,44, sd=,576)	4	4,1	47	48,0	47	48,0

Sources of prospective physics teachers' acquired knowledge about the concepts

To be able to answer research question 2, the frequencies of each source for different physics concepts were calculated as shown in Table 2. Only 44 of the 98 prospective physics teachers indicated their sources of acquired knowledge about the concepts. Over 90 percent of them indicated that they learned some of the concepts in courses at the university. These courses were indicated as "Classical Mechanics", "Nuclear Physics", "Quantum Physics", "Modern Physics", and "Optics". In addition, books, scientific journals, television and Internet were indicated as a source of acquired knowledge.

Table 2. The sources of acquired knowledge and frequencies of each source for different physics concepts

Sources / **Concepts**	Courses	Books	Scientific Journals	Television	Internet
Parallax	–	–	–	–	–
Parsec	–	–	–	–	–
Quasars	3	–	–	1	1
Binary Star	3	1	2	1	–
Infrasonic	4	1	–	–	–
Absolute Brightness	3	–	1	–	–
Cosmic Microwave Background Radiation	11	1	1	–	–
Neutron Star	6	–	2	2	1
Sonic Boom	4	2	–	2	2
Black and White Dwarfs	8	–	2	2	1
Biomagnetizm	7	–	2	–	1
Light Pressure	14	1	–	–	–
Shock Wave	10	1	–	4	1
Angular Magnification	10	1	–	–	–
Supersonic	8	–	1	5	1
Liquid Crystals	25	1	–	–	–
Rayleigh Criterion	19	2	1	–	–
Adhesion	28	2	–	–	1
Beat frequency	32	1	–	–	–
Cohesion	31	2	–	–	1
Lepton	37	1	–	–	–
Beat	35	1	–	1	–
Hadron	36	1	–	–	–
Electric Permittivity	34	1	–	–	–
Baryon	37	1	–	–	–
Meson	38	1	–	–	–
Capillarity	34	1	–	1	–
Quark	37	1	–	–	–
Inertial Reference System	36	2	–	–	–
Surface Tension	36	2	1	–	–
Harmonics	42	1	–	–	–
de Broglie Hypothesis	40	1	–	–	–
Total (f)	667	30	14	19	10

As shown in Table 2, many of the prospective teachers think that they have learned/seen the concepts from the courses. Only a few of them indicated other sources of knowledge in learning of physics concepts. However, the effect of television on the learning of 'shock wave' and 'supersonic' concepts cannot be disregarded. In addition, Internet and scientific journals contributes to learning of some astronomy related concepts such as 'binary star', 'neutron star' and 'black and white dwarfs'.

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Comparing Prospective Physics Teachers' Mean View Scores According to Different Universities, Years of Study and Genders

Independent *t*-test was performed by using SPSS to be able to answer research questions 3, 4 and 5. According to independent *t*-test results, there was no statistically significant difference in the mean view scores of female and male prospective physics teachers, 4^{th} and 5^{th} year prospective physics teachers, and prospective physics teachers in different universities at α=0.05 level, as shown in Table 3, Table 4 and Table 5.

Table 3. Comparison of prospective physics teachers' mean view scores according to different genders

Gender	N	X	Sd	df	t	p
Female	46	1,523	0.288	96	1,388	0,168
Male	52	1,448	0,244			

As indicated in Table 3, there is no statistically significant difference between female and male prospective physics teachers (t=1,388, p>0,05) in terms of their mean view scores. The mean view scores are 1,523 and 1,448 for female and male prospective physics teachers respectively.

In addition, mean view scores of male and female prospective physics teachers for each concept were given in figure 1.

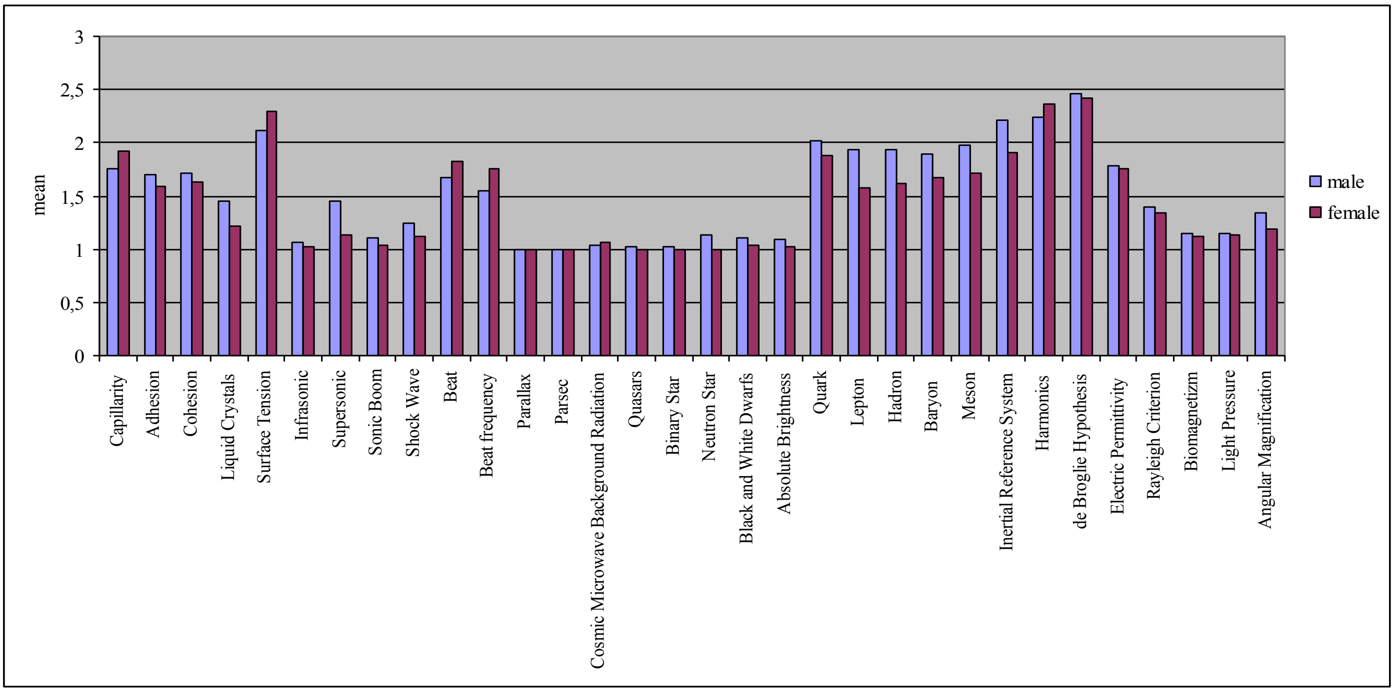

Figure 1. Histogram of mean view scores of male and female prospective physics teachers for each concept.

As shown in figure 1, there is no huge difference in mean view scores of prospective male and female physics teachers. In addition, female prospective physics teachers think themselves as more knowledgeable in the concepts related to subatomic particles than male prospective physics teachers according to figure 1. Another important result is the difference

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among the scores of male and female prospective physics teachers in the topic of sound. For example, male prospective physics teachers think themselves as more knowledgeable in the concepts of 'infrasonic', 'supersonic', 'sonic boom', and 'shock wave' than female prospective physics teacher, however, female prospective physics teachers think themselves as more knowledgeable in the concepts of 'beat' and 'beat frequency' than male prospective physics teachers. We think that 'infrasonic', 'supersonic', 'sonic boom', and 'shock wave' concepts may attract attention of male prospective physics teachers more.

Table 4. Comparison of prospective physics teachers' mean view scores according to different universities

Universities	N	X	Sd	df	t	p
University A	62	1,464	0,262	96	-0,933	0,353
University B	36	1,516	0,275			

As shown in Table 4, there is no statistically significant difference between University A and University B prospective physics teachers ($t=-0,933$, $p>0,05$) in terms of their mean view scores. The mean view scores are 1,464 and 1,516 for University A and University B prospective physics teachers respectively. Prospective physics teachers in both universities can have some problems in learning of physics concepts due to low mean view scores.

In addition, mean view scores of prospective physics teachers in University A and University B for each concept were given in figure 2.

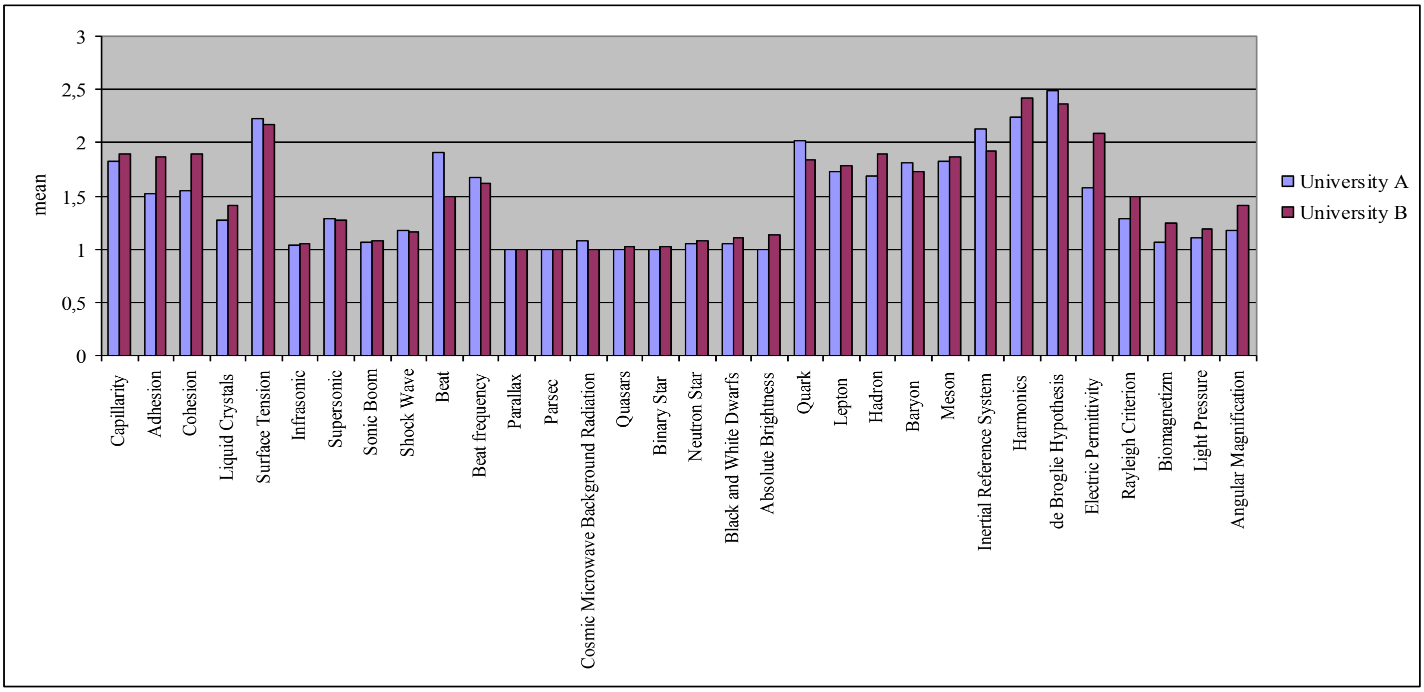

Figure 2. Histogram of mean view scores of prospective physics teachers in University A and University B for each concept

According to figure 2, mean view scores of prospective physics teachers in different universities are very close to each other. However, University B prospective physics teachers think themselves as more knowledgeable for 19 concepts than University a prospective physics teachers as seen in figure 2.

Table 5. Comparison of prospective physics teachers' mean view scores according to different years of study

Years of Study	N	X	Sd	df	t	p
4th year	62	1,501	0,271	96	0,878	0,723
5th year	36	1,452	0,260			

As shown in Table 5, there is no statistically significant difference between 4th and 5th year prospective physics teachers (t=0,878, p>0,05) in terms of their mean view scores. The mean view scores are 1,501 and 1,452 for 4th and 5th year prospective physics teachers respectively. Therefore, it can be claimed that prospective physics teachers' views about the concepts do not change in transition from 4th year to 5th year.

Finally, mean view scores of 4th and 5th year prospective physics teachers for each concept were given in figure 3.

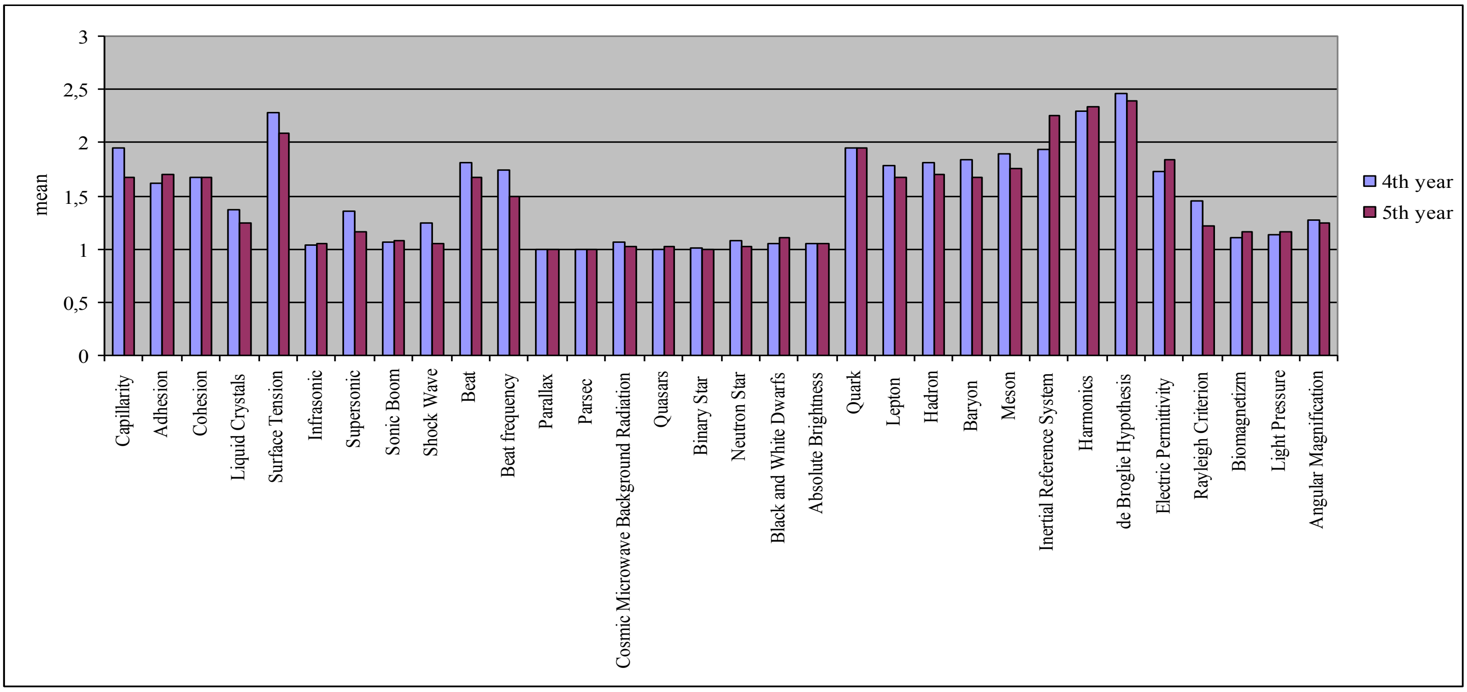

Figure 3. Histogram of mean view scores of 4th and 5th year prospective physic teachers for each concept

As shown in figure 3, interestingly, 4th year prospective physic teachers think themselves as more knowledgeable in the concepts related to subatomic particles than 5th year prospective physics teachers.

Discussion

Firstly, prospective physics teachers' views on their knowledge about the new physics concepts introduced in Turkish High School Physics Curricula were explored in this study. Secondly, the sources of their acquired knowledge about these new physics concepts were determined. Finally, whether three is a difference in their views on their knowledge about the new physics concepts according to different genders, years of study and universities was investigated.

The results of this study showed that prospective physics teachers did not think themselves as knowledge enough about new concepts. They were deficient in new concepts particularly related to astronomy and sound subjects. In fact, our expectation before administering the questionnaire was that they would consider themselves as more knowledgeable about astronomy concepts than the concepts related to subatomic particles due to widespread use of astronomy concepts in daily life. Contrary to our expectations, they considered themselves as more knowledgeable in the topic of subatomic particles. Ünsal et al. (2001), similar to our study, found that teachers graduated from universities with insufficient and wrong information about astronomy. Although our study is different in terms of the methodology used and concepts investigated, it is obvious that prospective teachers do have a limited understanding of the astronomy related concepts.

In addition, prospective physics teachers thought that they were more knowledgeable about the concepts related to subatomic particles than the concepts related to other subjects of this study. When we examine the courses indicated by prospective physics teachers as a source of their knowledge, three of the courses were on the subjects of subatomic particles except two courses on ‘Optics’ and ‘Classical Mechanic’. Interestingly, none of the participants indicated astronomy courses and education courses as a source of their knowledge. A few participants indicated different sources of knowledge such as Internet and scientific journals in the questionnaire. Another important finding was that none of the participants indicated their acquired source of knowledge as high school physics curricula. Therefore, many of them can be content with only physics courses in their university life.

Another finding in this study was prospective teachers’ low view scores about sound concepts. Although “Optics and Waves” course is given as a compulsory course to the prospective physics teachers in both physics and physics education programmes of secondary science and mathematics education departments, low scores of sound concept can be viewed as a limitation of the university education as a preparation for physics teachers’ subject matter knowledge.

Statistically insignificant difference between mean view scores of 4^{th} and 5^{th} year prospective physics teachers indicates that prospective physics teachers cannot improve themselves in a one year period in terms of physics knowledge. The reason for this can be the fact that education courses are spread over 4^{th} and 5^{th} years, whereas there are no physics courses, at least for the regular students, during the last years. Not having an opportunity to discuss physics concepts adequately in these lessons can be the reason of similar views of 4^{th} and 5^{th} year prospective physics teachers. In addition, KPSS (an examination which has to be passed to become a teacher in public schools in Turkey) may affect prospective teachers’ improvement in their physics knowledge. Therefore, they may ignore studying physics because this exam does not measure prospective physics teachers’ knowledge of physics.

In addition, no statistically significant difference was found between mean view scores of female and male prospective physics teachers in this study. The results are in accordance with the results of earlier studies (Çekbaş & Kara, 2009; Kahyaoğlu & Yavuzer, 2004) investigating whether there was a difference between physics test scores of prospective teachers related to gender. It is reasonable to argue that female and male prospective physics teachers think themselves as having same amount of knowledge about physics concepts.

Another important result of this study was that there was no statistically significant difference among mean view scores of prospective physics teachers in different universities. This result may indicate that prospective physics teachers in these two universities are trained in the same way.

Conclusion and Implications

The low scores of prospective physics teachers about physics concepts cannot be ignored by physics education researchers. Some precautions should be taken urgently for more permanent physics concept learning in universities. In addition, mastery learning approach to learning of physics concepts can be espoused in university education. In this way, prospective teachers can graduate from universities having better knowledge about concepts and how to teach them.

Lack of understanding of certain physics concepts, as reported by the participants themselves, points out to problems related to how physics is taught at university level. Mismatch between the content of the university courses and high school physics courses or not teaching all physics concepts in the high school physics curricula to prospective physics teachers at university years may have caused low view scores of prospective physics teachers. The study of Karakuyu (2008) indicated that over 50% of physics teachers believed in a mismatch between curriculum and university education. University physics education programmes should adapt to an approach to include concepts and phenomena in high school physics curricula in addition to their actual curricula. Additionally, lecturers in physics departments and physics education programmes of secondary science and mathematics education departments, as well as prospective physics teachers, should be well informed about the content of high school physics curricula.

It is revealed in this study that prospective physics teachers did not consider themselves as knowledgeable enough about particularly two subjects: astronomy and sound. Courses on these subjects, perhaps at a sufficiently basic level, should be compulsory, at least for the prospective physics teachers, if not for the physics students.

In addition, graduating from universities not knowing the concepts included in the high school physics curricula, might result in serious problems in prospective physics teachers' attitude toward teaching of those concepts in their professional life. For example, they may skip some units on astronomy due to their lack of knowledge about concepts. Alternatively, they may, feeling insecure, rely too much on textbooks, and methods where student active participation is undermined. Or they may avoid student questions, which would then result other problems. To avoid such scenarios, initial teacher education programmes have to ensure that their graduates are equipped with the subject matter knowledge that they will be responsible for teaching.

Many of the prospective physics teachers indicated sources of their knowledge as physics courses. Therefore, physics lecturers and physic departments have big responsibility in the prospective teachers' conceptual understanding of physics concepts. Physics lectures should emphasize concepts indicated in the high school physics curricula in their lessons. In addition, prospective physics teachers should be encouraged to learn concepts not only from their courses but also from Internet, documentaries, books, and scientific journals. Moreover, active participation should be encouraged and experienced by the prospective physics teachers during those courses, in order to make them see the value in it.

In this study, prospective physics teachers indicated their views on knowledge about physics concepts. However, it would be wrong to say that the questionnaire used in this study measures prospective physics teachers' actual knowledge about the concepts used in this study. Some of the concepts with view scores above a certain average point can and should be examined again by asking them to explain the concepts. In addition, other concepts from different units should also be investigated. In this way, areas of support prospective physics teachers need as regards their content knowledge can be identified.

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Appendix

The questionnaire "Physics Concepts Knowledge Questionnaire" was prepared to determine prospective physics teachers' views on their knowledge about the new physics concepts introduced in the Turkish High School Physics Curricula. This questionnaire consists of four alternatives, which are "I have never seen the concept before"; "I saw the concept before but I have no knowledge about the concept"; "I have little knowledge about the concept"; and "I know enough about the concept". Please be honest in choosing the alternatives. Don't forget to indicate where they saw/learned the concepts.

University: ……………………..
Gender: **Male** ☐ **Female** ☐
Grade level: **4th** ☐ **5th** ☐

Physics Concepts Knowledge Questionnaire

Concepts	I have never seen the concept before	I saw the concept before but I have no knowledge about the concept	I have little knowledge about the concept	I know enough about the concept	Where did you see/learn concept
Inertial Reference System	O	O	O	O	
Surface Tension	O	O	O	O	
Harmonics	O	O	O	O	
de Broglie Hypothesis	O	O	O	O	
Capillarity	O	O	O	O	
Adhesion	O	O	O	O	
Cohesion	O	O	O	O	
Beat	O	O	O	O	
Beat frequency	O	O	O	O	
Electric Permittivity	O	O	O	O	
Rayleigh Criterion	O	O	O	O	
Liquid Crystals	O	O	O	O	
Biomagnetizm	O	O	O	O	
Light Pressure	O	O	O	O	
Infrasonic	O	O	O	O	
Supersonic	O	O	O	O	
Sonic Boom	O	O	O	O	
Shock Wave	O	O	O	O	
Parallax	O	O	O	O	
Parsec	O	O	O	O	
Absolute Brightness	O	O	O	O	
Cosmic Microwave Background Radiation	O	O	O	O	
Angular Magnification	O	O	O	O	
Quasars	O	O	O	O	
Binary Star	O	O	O	O	
Neutron Star	O	O	O	O	
Black and White Dwarfs	O	O	O	O	
Quark	O	O	O	O	
Lepton	O	O	O	O	
Hadron	O	O	O	O	
Baryon	O	O	O	O	
Meson	O	O	O	O	