Turkish Studies
International Periodical for the Languages, Literature and History of Turkish or Turkic
Volume 12/25, p. 625-650
DOI Number: http://dx.doi.org/10.7827/TurkishStudies.12213
ISSN: 1308-2140, ANKARA-TURKEY

Article Info/Makale Bilgisi
Referees/Hakemler: Prof. Dr. Mehmet KÖÇER – Doç. Dr. Mesut GÜN – Yrd. Doç. Dr. Murat ŞENGÜL – Yrd. Doç. Dr. Hasan Hüseyin KILINÇ

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PROSPECTIVE PRIMARY SCHOOL TEACHERS' LEVELS OF READINESS FOR SCIENCE EDUCATION TOPICS

Alper Murat ÖZDEMİR[*]

ABSTRACT

In self- actualizing of human, giving a meaning to surroundings and self of human has an important role. One of the education aims is help for human in self-actualizing. So, concepts have a distinct importance for education. According to constructivist theory of learning, students' prior knowledge plays an essential role in subsequent learning. Identification of misconceptions in the life of a teacher training college teacher candidates related to the concept of the science and technology in the classroom and students will use when considering them in terms of both importance. This research aims to determine prospective Primary school teachers' levels of acquiring the concepts available in the science education topics. A misconception can be defined as an individual's understanding of a concept as substantially different from the commonly accepted scientific meaning of it. For students misconceptions are not different from other explanatory information and are organized very much the same way, developed for most scientific phenomena, and as a result are persistent to change. The prospective teachers' acquisition levels are likely to have a direct effect on students' status of structuring the concepts, who will encounter the most basic concepts of science in the fourth and fifth grades. In this sense, this research employs a descriptive research design. The research data were obtained through "Science and Technology Course Concept Scale" by applying it on 93 prospective teachers studying in the Educational Faculty of Nevşehir University. The fact that the measurement tool required students to give short answers beside the knowledge of concepts enabled us to identify their misunderstandings concerning the concepts. In consequence, it was found that while prospective teachers' gender properties and the school of graduation were not influential in their levels of understanding the science concepts, the units causing the most difficulty on the part of students were "Let's Do the Puzzle of our Body" and "the Units of Electricity in Our Life"; but the unit they found the easiest was "Force and Movement".

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STRUCTURED ABSTRACT

Introduction

Teacher proficiency is one of the controversial issues of today's educational system. Although varying quantities and qualities are mentioned in different sources, it is commonly stated that field knowledge (planning the teaching, topic field, field education, etc.) constitutes a considerable part of teaching occupation proficiency (Schallcross and Spink, 2002; Ministry of Education, 2002; Board of Higher Education, 1998).

The Aim of Research

This study aims at determining the prospective primary school teachers' levels of acquiring the concepts of science and technology available in the units of science and technology courses as well as their misconceptions. Thus, determining their levels of such knowledge and structuring the concepts accurately and meaningfully very soon will make significant contributions to removing probable misconceptions firstly in prospective teachers and secondly in students to be educated by them.

Method and Research Model

This study employs a survey model. Survey models are surveying of a whole population or of a group, a sample representative of the population so as to arrive at a general conclusion about a population which is composed of a great many numbers of elements (Cohen, Manion and Morrison, 2000; Muijs, 2004).

Study Group

The study group of the research was composed of 93 prospective teachers, the fourth year students, who were attending the primary school teaching department of the Educational Faculty of Nevşehir Hacı Bektaş Veli University (58 female students (62.4%) and 35 male students (37.6%)). The students in the study group were randomly chosen.

Collecting Data

A two-part measurement tool which was developed by the researchers was employed in data collection. A "personal Information Form" with five questions to identify the personal information about the prospective teachers is included in the first part whereas a 103-item "Science and Technology Course Concept Scale" (STCCS) is included in the second part so as to determine the prospective teachers' levels of understanding some of the concepts of science and technology topics as well as their misconceptions.

115 concepts were determined from the spirally prepared 7 units of the 4th and 5th grades and a pool of concepts was formed in preparing the items in the measurement tool. Expert opinion was consulted for the items in the pool of concepts, and the concepts which were thought to consist of each other were grouped under the same headings. Having achieved content validity of the measurement tool and having performed the pilot application, item difficulty and distinguishing indices were examined; and 12 concepts were removed from the tool. In its final form

the STCCS consisted of 103 items (chemistry: 28, physics: 29, biology: 46) and Kuder Richardson-20 internal reliability coefficient was found to be 0.72. This finding showed that the measurement tool would yield reliable results (Kalaycı, 2009).

Data Analysis

The SPSS 15.0 programmes were employed in analysing the data, and descriptive and explanatory statistics were also used. Frequency (f) and percentage (%) techniques were used in describing the prospective teachers' demographic features and their views while the t-test was used in examining their views on the basis of gender characteristics. Moreover, one-directional variance analysis (ANOVA) was performed to study the differences on the basis of the school of graduation whereas Pearson's correlation coefficient technique was used in determining the correlations between the dependent variables. 0.5 significance level was considered in interpreting the data.

Findings

When an overall evaluation was made on the basis of units, it was found that the highest number of correct answers was in the unit of Force and Movement (90%) whereas the lowest number was in the units of Let's Do the Puzzle of Our Body (59.7%) and Electricity in Our Life (59.4%). The highest number of correct answers was in the concepts of physics, but the number was the lowest in biology concepts (62.2%). And also there are no correlations between the students' STCCS achievement and chemistry achievement (r=,012; p>.05) and physics achievement (r=,026; p>.05) but that there is a weak negative correlation with biology grades (r=-,220; p>.05). Besides, a significant negative correlation between biology achievement grade and the achievement average in unit 3 (Force and Movement) (r=,284;p<.01) and a significant positive correlation between chemistry achievement grade and the achievement average in unit 6 (Let's travel into the World of Living Things) are available (r=,214;p<.01).

Conclusion and Interpretation

It was found in this research that the majority of the prospective primary school teachers were at low levels of understanding some of the basic physical, chemical and biological concepts and that they had misconceptions. The units in which the prospective teacher had the most difficulty were "Let's Do the Puzzle of Our Body" and "the Electricity in Our life" while the level of achievement was the maximum in the unit of "Force and Movement". Moreover, there were no differences between structuring the concepts on the basis of gender and of the secondary education school of graduation. Whereas there were no correlations between the prospective teachers' STCCS achievement and chemistry and physics achievement, a significant negative correlation was found with biology achievement grades. This finding showed that those courses taken in the first three years of university education were not sufficiently influential in students' correcting their misconceptions and in their making sense of the concepts.

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basic physical, chemical and biological concepts and that they had misconceptions. The units in which the prospective teacher had the most difficulty were “Let’s Do the Puzzle of Our Body” and “the Electricity in Our life” while the level of achievement was the maximum in the unit of “Force and Movement”. Moreover, there were no differences between structuring the concepts on the basis of gender and of the secondary education school of graduation. Whereas there were no correlations between the prospective teachers’ STCCS achievement and chemistry and physics achievement, a significant negative correlation was found with biology achievement grades. This finding showed that those courses taken in the first three years of university education were not sufficiently influential in students’ correcting their misconceptions and in their making sense of the concepts. In line with the findings, the following recommendations may be made:

The causes of misconceptions can be grouped into two: The first is the factors of course books, the teacher, and students’ ignorance of previous knowledge. The second is failing to bring about the necessary conceptual change in students during the class (Yılmaz, Tekkaya, Geban and Özden, 1999). Thus, science based courses that are offered in educational faculties at undergraduate level could be designed in a manner so as to help students to structure the concepts better and to remove their misconceptions and could be enriched with concept teaching techniques (such as analogies, associating with daily life, two dimensional designs, concept maps, concept networks, meaning analysis charts, diagrams, etc.) and thus concept teaching may be performed.

Keywords: Concept teaching and learning, Misconceptions, Science and Technology course

ÖĞRETMEN ADAYLARININ FEN KONULARINDAKİ HAZIR BULUNUŞLUK DÜZEYLERİ

ÖZET

İnsanın kendini gerçekleştirmesinde, çevresini ve kendisini anlamlandırmasının rolü büyüktür. Eğitimin hedeflerinden biri, insanın kendisini gerçekleştirmesine yardım etmektir. Bu nedenle kavramlar, eğitim için ayrı bir öneme sahiptir. Yapılandırmacı öğrenme teorisine göre, sonraki öğrenmeler önceki bilgilerin üzerine inşa edildiği için, öğrencilerin sahip oldukları ön bilgiler ve yanlış kavramalar öğrenmede son derece önemlidir. Kavram yanılgısı, bir kişinin bir kavramı anladığı şeklin, ortaklaşa kabul edilen bilimsel anlamından önemli derecede farklılık göstermesi şeklinde ifade edilebilir. Kavram yanılgıları, öğrenciler için diğer açıklayıcı bilgilerden fazla farklılık göstermezler, aynı şekilde düzenlenirler, yeni bilgilerin genelinde yer alırlar ve sonuç olarak kavram yanılgılarını ortadan kaldırmak zordur. Kavram yanılgılarının belirlenmesi Eğitim Fakültesi öğretmen adaylarının öğretmenlik hayatında da fen ve teknoloji ile ilgili kavramları sınıflarda kullanacakları düşünüldüğünde hem kendileri hem de öğrencileri açısından önem taşımaktadır. Bu araştırmada ilkokul öğretmen adaylarının fen ve teknoloji derslerinde yer alan kavramları anlamalarını belirlemek

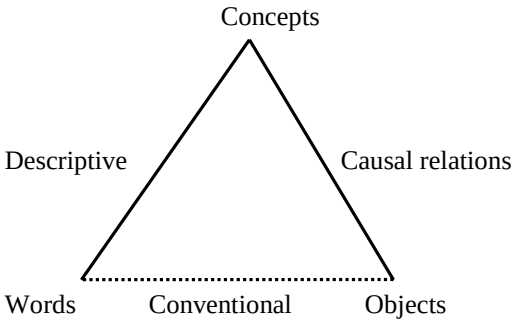
amaçlanmıştır. Öğretmen adaylarının kazanım seviyeleri ilkokul fen derslerinde en bilinen kavramlarla karşılaşan öğrencilerin kavramları yapılandırma durumlarından doğrudan etkilenir. Bu durumda araştırma betimsel olarak yapılmıştır. Araştırmada verileri Nevşehir Üniversitesinde okuyan 93 öğretmen adayına Fen ve Teknoloji Dersi Kavram Ölçeği uygulanmıştır. Ayrıca öğretmen adaylarının anlama düzeyleri ve kavram yanılgıları bazı değişkenler açısından incelenmeye çalışılmıştır. Yapılan analiz sonuçları öğretmen adaylarının fen ve teknoloji dersi ünitelerindeki Vücudumuzun bilmecesini çözelim ve Yaşamımızdaki Elektrik fazlayken, Kuvvet ve Hareket ünitesinde daha az kavram yanılgılarına sahip oldukları ve anlama düzeyleri açısından bir takım sorunlarla karşılaştıklarını göstermiştir.

Anahtar Kelimeler: Kavram Öğretimi, Kavram Yanılgıları, Fen ve Teknoloji dersi

Introduction

Teacher proficiency is one of the controversial issues of today's educational system. Although varying quantities and qualities are mentioned in different sources, it is commonly stated that field knowledge (planning the teaching, topic field, field education, etc.) constitutes a considerable part of teaching occupation proficiency (Schallcross and Spink, 2002; Ministry of Education, 2002; Board of Higher Education, 1998). The teacher candidates with high self-efficacy beliefs will be more determined, knowing what he wants and what he must do. In this study, the science literacy of the teacher candidates were explained in terms of the variables, epistemological belief and self-efficacy belief for science teaching, and the reasons and results were discussed comparatively. (Yavuz, Kırındı and Kandemir, 2017). The fact that primary school teaching is a multi-disciplinary field requires that prospective teachers who are graduates of those related fields should possess field knowledge proficiency in various disciplines as a prerequisite. One of those disciplines is Science and Technology course. Scientific knowledge that is contained in science studies is the knowledge which has been refined through human beings' interaction with their natural environment so as to meet their needs, which has been accumulated for centuries by organising in an appropriate way, and which has been passed down from generation to generation since human beings' emergence on the earth; and it is proved to be reliable and durable (Çilenti, 1985). This is the basic knowledge to facilitate man to research further and get to know better the self and the environment and to make new attempts at obtaining new knowledge in the field of science. This basic knowledge may be grouped into (1) phenomenal propositions, (2) concepts, (3) generalisations, (4) laws, (5) hypotheses, and (6) theories (Çilenti, 1985; Board of Higher Education, 1998; Aydoğdu and Kesercioğlu, 2005, Çepni, 2007).

For descriptive dictionaries, concepts are the meaning units of a language (Yıldırım, 1998). A concept is, in general sense, a form/structure of knowledge representing the changeable common features of different objects and phenomena; it is a variable and may be stated in a word (Ülgen, 2001). Çepni (2007) suggests that concepts are the units of abstract thinking in our mind rather than tangible possessions, entities or situations. Senemoğlu (2005), however, believes that concepts are necessary for thinking. Understanding the concepts is necessary for understanding the principles, for solving the problems and for understand the world. Therefore, some of the concepts are simpler whereas others are more complex (Senemoğlu, 2005). The diagram below shows the relations between words, concepts and objects.



Three types of relations are remarkable in the diagram. The relation shown by broken lines at the bottom of the triangle is between the word the type of object represented by the word; and this relation is dependent on our habit in a way and on our shared acceptance but may not be said to be a natural or causal relation; and is therefore a conventional relation. The second relation in the diagram holds between the object named by the word and the concept which is composed of the shared properties of that type of object. The relation which may be said to be causal is connected with observation data and is not dependent on our supposition or shared acceptance. The third relation holds between the word and the concept represented by the word. Because the properties composing the concept are the descriptive elements of the word, this relation is labelled as a descriptive relation (Yıldırım, 1998). Concepts are the building blocks of knowledge whereas conceptual relations are the scientific structures (Kaptan, 1998). Learning- that is to say, conceptual change- is achieved by acquiring new knowledge and revising the current knowledge (Yağbasan and Gülçiçek, 2003). Concept learning, on the other hand, is described as the state of being able to classify objects, actions and people and being able to respond to that class as a whole (Özyürek, 1983). Concepts become meaningful through the classification of novel knowledge generated day by day. In other words, concept learning starts at birth and continues until death. Concepts, knowledge and principles to be learnt become meaningful once they have been associated with previously learnt knowledge. However, the most important issue remarkable is the perception and storage of correct concepts as knowledge by the learner. Misconceptions are students' uncorrect thoughts about a specific problem or are non-scientific knowledge. That stems most probably from misunderstanding the topics presented. The way a teacher presents a topic in teaching practice can also result in misconceptions. Besides, misconceptions can also arise when students connect what they learn with what they have learnt before (Morgil and Yılmaz, 2001). Although misconceptions are present at every stage of life, they are commonly encountered in schooling period. Baki (1999) defines misconceptions as behaviours arising due to students' misbelieve and experiences whereas Çakır and Yürük (1999) define them as knowledge which is formed through personal experience, which is contrary to scientific facts, and which hinders the teaching and learning of concepts proven by science to be correct. The most important feature of misconceptions is that students consider them as knowledge and that they do not see them different from other knowledge. Provided that they are corrected in time, misconceptions are one of the improving thinking processes in terms of teaching (Rowell, Dawson and Harry, 1990). In consequence, understanding the place concepts occupy in science and in people's knowledge, knowing the ways of concept learning and concept teaching provide teachers with invaluable knowledge and skills. Students' development of correct concepts in their academic career is very important in terms of teaching goals. The extent to which a student comprehends or internalises a concept or idea associated with science studies is closely related with the way he or she organises the knowledge as well as with the meaning he or she loads into the knowledge (The Board of Higher education/World Bank, 1998). Thus, determining the students' levels of knowledge about the concepts and their misconceptions -if there are any - is very important.

Apart from that, the primary education is the level at which students start learning the concepts about science for the first time. In other words, students encounter the most basic concepts of science at that time and those concepts form the basis to learn many concepts of more advanced levels. This case requires that primary school teachers' levels of knowledge of the basic concepts as well as the degree of their accuracy should be determined. Structuring the concepts accurately and adequately is directly related with occupational proficiency and therefore teachers' deficiencies in this matter should be determined.

This study aims at determining the prospective primary school teachers' levels of acquiring the concepts of science and technology available in the units of science and technology courses as well as their misconceptions. Thus, determining their levels of such knowledge and structuring the concepts accurately and meaningfully very soon will make significant contributions to removing probable misconceptions firstly in prospective teachers and secondly in students to be educated by them. For those purposes, the following sub-problems are tested in this research:

1. What are the educational faculty students' levels of giving meaning to the concepts of science and technology courses?

2. Do the students have misconceptions in science and technology course topics?

3. Do the students' levels of understanding some of the concepts of science and technology course and their misconceptions

   a. Differ significantly according to their gender characteristics?

   b. Differ significantly according to the school of graduation?

   c. Have any relations with their levels of achievement?

Method

Research Model

This study employs a survey model. Survey models are surveying of a whole population or of a group, a sample representative of the population so as to arrive at a general conclusion about a population which is composed of a great many numbers of elements (Cohen, Manion and Morrison, 2000; Muijs, 2004). In such an approach, an attempt is made to describe the variables of the action, item, individual, group, unit or situation in question separately. This study also makes an attempt at describing the prospective teachers' levels of understanding the concepts of science and technology course and their misconceptions.

Study Group

The study group of the research was composed of 93 prospective teachers, the fourth year students, who were attending the primary school teaching department of the Educational Faculty of Nevşehir Hacı Bektaş Veli University (58 female students (62.4%) and 35 male students (37.6%)). The students in the study group were randomly chosen.

Data Collection Tools and Their Development

A two-part measurement tool which was developed by the researchers was employed in data collection. A "personal Information Form" with five questions to identify the personal information about the prospective teachers is included in the first part whereas a 103-item "Science and Technology Course Concept Scale" (STCCS) is included in the second part so as to determine the prospective teachers' levels of understanding some of the concepts of science and technology topics as well as their misconceptions.

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For the purposes of determining the levels of knowledge about the concepts, an explanation section was included next to each concept in order for the prospective teachers to state their opinions. The respondents had to think about and write the answers, and the test items tested the ability to recall and find the knowledge. The tool was also advantageous in that it required varying knowledge, the answers were short and thus many concepts could be tested and scoring became easier, and that it provided independence in responding to the questions. Along with those advantages, it enabled the researchers to determine the students' misconceptions (Turgut, 1992; Tekin, 2000; Taşdemir, 2003). In addition to that, end-of- the -year grades received by the undergraduate students in physics, chemistry and biology courses were also used in the research.

Data Analysis

The SPSS 15.0 programmes were employed in analysing the data, and descriptive and explanatory statistics were also used. Frequency (f) and percentage (%) techniques were used in describing the prospective teachers' demographic features and their views while the t-test was used in examining their views on the basis of gender characteristics. Moreover, one-directional variance analysis (ANOVA) was performed to study the differences on the basis of the school of graduation whereas Pearson's correlation coefficient technique was used in determining the correlations between the dependent variables. 0.5 significance level was considered in interpreting the data.

In analysing the data, the causes given by the prospective teachers were divided into three categories as "correct", "partially correct", and "incorrect"; and their percentages were calculated. When determining the categories, the student answers explaining the activity fully were placed into the "correct" category; and the answers which were acceptable but failed to explain fully were placed into the" partially correct" category. The answers in the "correct" category were assigned 1 point whereas those in the "partially correct" or "incorrect" category were assigned 0 point; and thus the prospective teachers' "correct"s for each unit and for the overall total were analysed. Samples to represent the levels of understanding and the misconceptions selected from the answers given by the prospective teachers were used in the research to support the quantitative data.

Results Of The Study

The data obtained were interpreted separately for seven units, and the answers given were compared according to the independent variables in the final part.

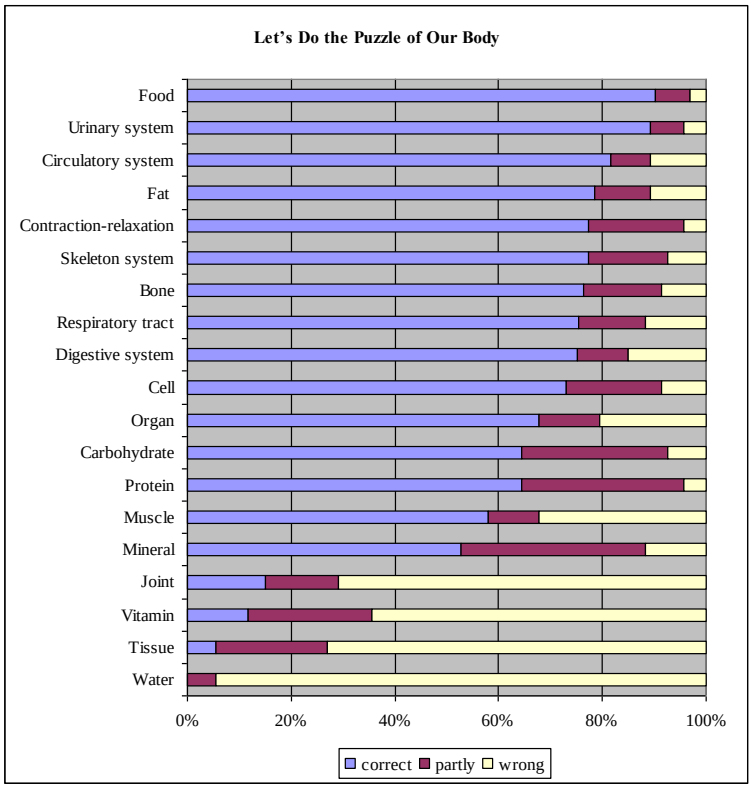

Figure 1. Findings concerning the concepts in the unit "Let's Do the Puzzle of Our Body"

On examining Figure 1, it was found that the prospective teachers' answers were highly correct for the concepts of food *(90.3%)*, excretory system *(89.2%)*, circulatory system *(81.7%)*, fat *(78.5%)*, skeleton system *(77.4%)*, contraction-relaxation *(77.4%)*, bones *(76.3%)*, respiratory system *(75.3%)*, and digestive system *(75.3%)*. However, they were found to have difficulty in defining the concepts of digestive system *(24.8%)*, skeleton system *(22.6%)*, respiratory system *(24.7%)*, bones *(23.7%)*, contraction-relaxation *(22.6%)*, cells *(26.9%)*, organs *(32.2%)*, protein *(34.5%)*, fat *(21.6%)*, and carbohydrate *(25.5%)*. Besides, it was also found that the students could not make sense of the concepts of muscle *(32.3%)*, joint *(71%)*, tissue *(73.1%)*, mineral *(11.8%)*, vitamin *(64.5%)*, and especially water *(94.6%)* in defining and that they had misconceptions in those concepts. The detailed examples of their answers are shown below.

Bone: "is not a tissue", "I don't think is functions as a support"

Fat: "does not provide energy"

Vitamin: "is organic", "is a food providing energy"

Cell: "the small, sectional structure of substance", the smallest structure", "the smallest building block of the body"

Digestive system: "only chemical digestion is performed"

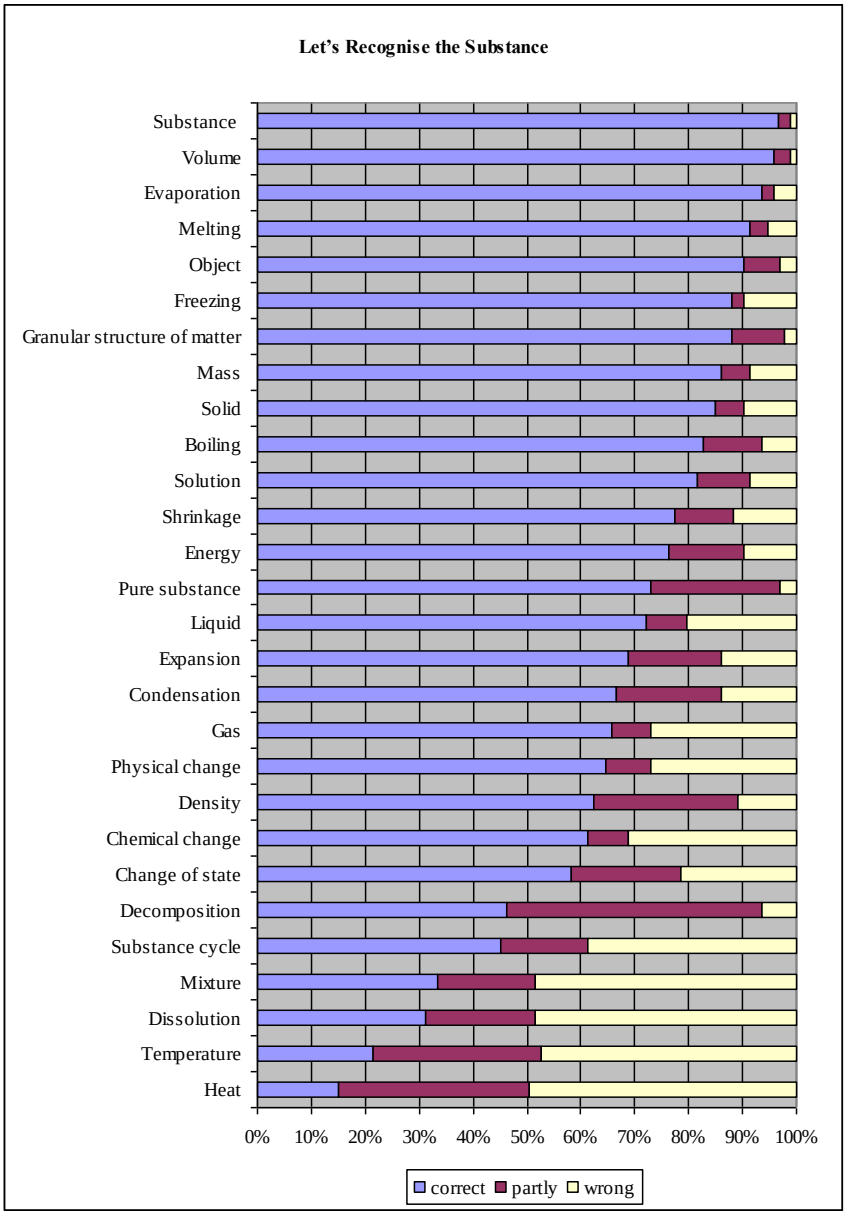

Figure 2. Findings concerning the concepts in the unit "Let's Recognise the Substance"

On examining Figure 2, it was found that the prospective teachers could define the concepts of substance *(96.8%)*, volume *(95.7%)*, the granular structure of substance *(88.2%)*, solid *(84.9%)*, boiling *(82.8%)*, solution *(81.7%)*, shrinkage *(77.4%)*, energy *(76.3%)*, pure substance *(73.1%)*, and liquid *(72%)* accurately. Yet it was found that they had problems with such concepts as gas *(65.6%)*, condensation *(66.7%)*, expansion *(68.8%)*, chemical change *(61.3%)*, density *(62.4%)*, and physical change *(64.5%)*. It was also found that they could not make sense of the concepts of degradation *(53.8%)*, mixture *(66.7%)*, dissolution *(68.8%)*, heat *(85%)*, hotness *(78.5%)* and change of state *(41.9%)* and that they had misconceptions in those issues. Some examples are shown below to support this finding.

Gas: "is not fluid", "does not take the shape of the container"

Density: "density is a different term", "mutual approaching of the granules of substance" "expresses the scattering of a substance"

Matter: "water is also a matter but it doesn't have a shape"

Liquid: "the regular state of substance", "it is not the most irregular"

Energy: "the average movement energy of the granules of substance"

Heat: "is the emerging energy", "the coming out of the potential energy inside the substance"

Change of state: "the concentration or sublimation of substances", "the change of the substance"

Solution: "heterogeneous mixture"

The granular structure of substance: "a substance smaller than the atom"

Mass: "the amount of changeable substance"

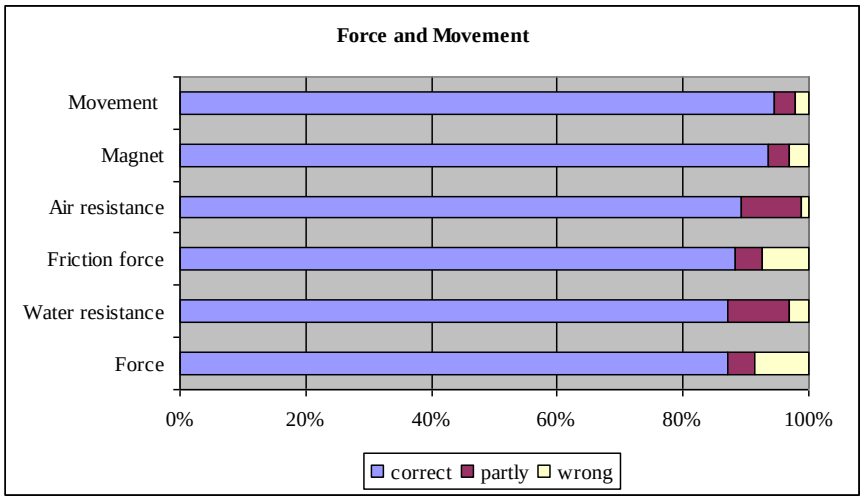

Figure 3. Findings concerning the concepts in the unit "Force and Movement"

On examining Figure 3, it was found that the prospective teachers defined the concepts of movement *(94.6%)*, magnet *(93.5%)*, air resistance *(89.2%)*, force *(87.1%)*, water resistance *(87.1%)* and friction force *(88.1)* in the unit of Force and Movement with high accuracy. The examples from students' answers which were incorrect or partially correct are shown below:

Magnet: attracts also the poles"

Friction force: "passive force"

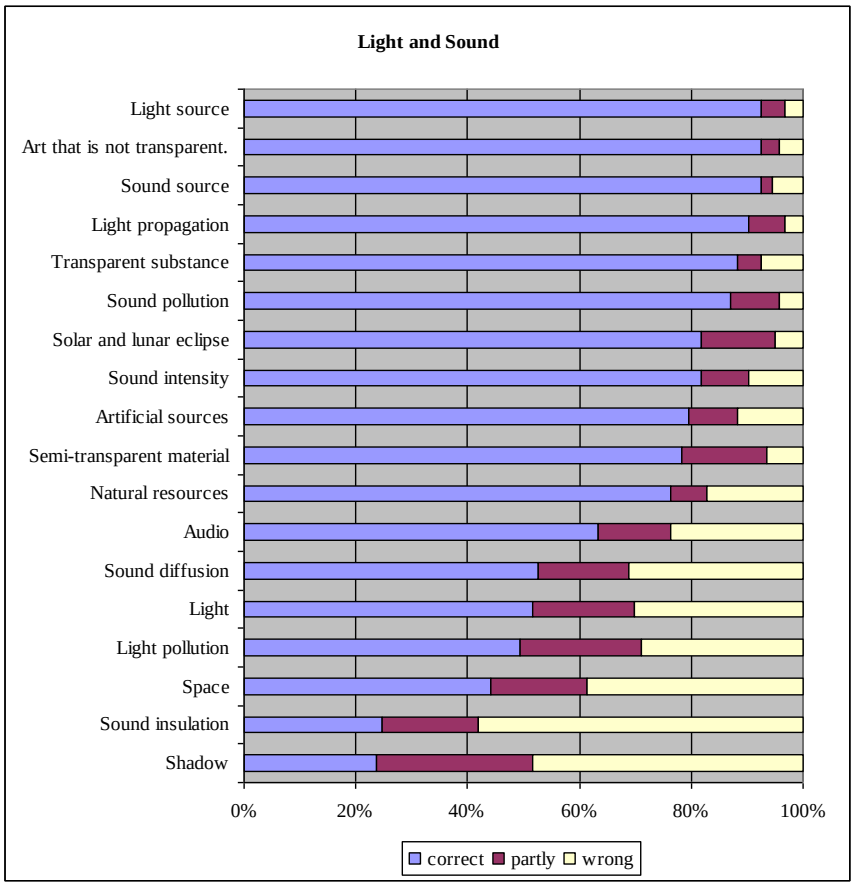

Figure 4. Findings concerning the concepts in the unit "Light and Sound"

On examining Figure 4, it was found that the prospective teachers mostly answered the questions about the concepts of the source of light *(92.5%)*, source of sound *(92.5%)*, opaque substance *(92.5%)*, spread of light *(90.3%)*, transparent substance *(88.2%)*, sound dirtiness *(87.1%)*, solar eclipse/ obscuration *(86.6%)*, intensity of sound *(81.7%)*, artificial resources *(79.6%)*, natural resources *(76.3%)*, and semi transparent substance (*78.5%)* correctly. However, they were found to have problems although they were able to define correctly the concepts such as natural resources *(23.7%)*, artificial resources *(20.4%)*, semi-transparent substance *(21.6%)*, and solar eclipse/obscuration *(19.4%)*. Besides the concepts that they had difficulty were sound isolation *(58.1%)*, shadow *(48.4%)*, space *(38.7%)*, the spread of sound *(31.2%)*, light dirtiness *(29%)*, light *(30.1%)*, and sound *(23.7%)*. The sample answers are shown below.

Sound isolation: "regression of sound waves"

Space: "there may be air in it", there is also air inside the space", "air is available at any case"

Shadow: "the reflection of the matter without light due to lights"

Solar eclipse/obscuration: "this occurs when they rather than their shadows overlap

Sound: "the energy facilitating enlightenment is the sound"

Light dirtiness: "too much light"

Breaking of light: the hitting of light into a hurdle"

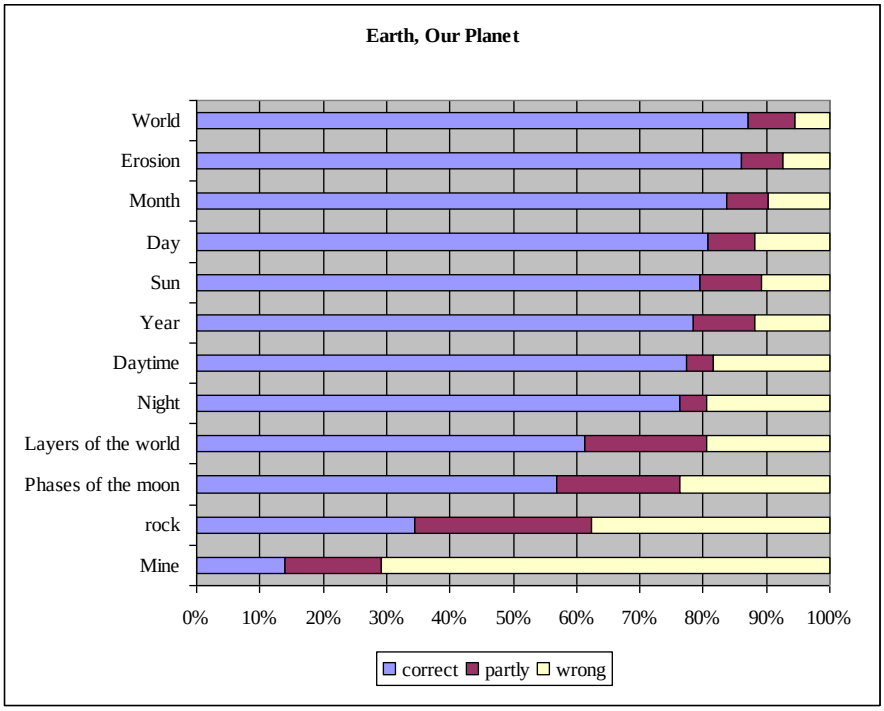

Figure 5. Findings concerning the concepts in the unit "Earth, Our Planet"

On examining figure 5, it was found that although the prospective teachers defined the concepts of earth *(87.1%),* erosion *(86%),* moon *(83.9%),* sun *(79.6%),* day *(80.6%),* year *(78.5%),* night *(76.3%),* and daytime *(77.4%)* mostly correctly, they may be said to have problems especially in the concepts of night *(19.4%),* daytime *(18.3%),* year *(11.8%),* day *(11.8%),* and sun *(10.8%).* In addition, it was also found that the students' definitions were incorrect and were not correctly structured in the concepts of mine *(71%),* rock *(37.6%),* the layers of the earth *(19.4%),* and the phases of the moon *(23.7%).* The samples from students' answers are shown below.

The layers of the earth: "The layers of the earth are in the underground", "are invisible", "the earth has got layers such as magma"

The phases of the moon: "are the layers of the moon"

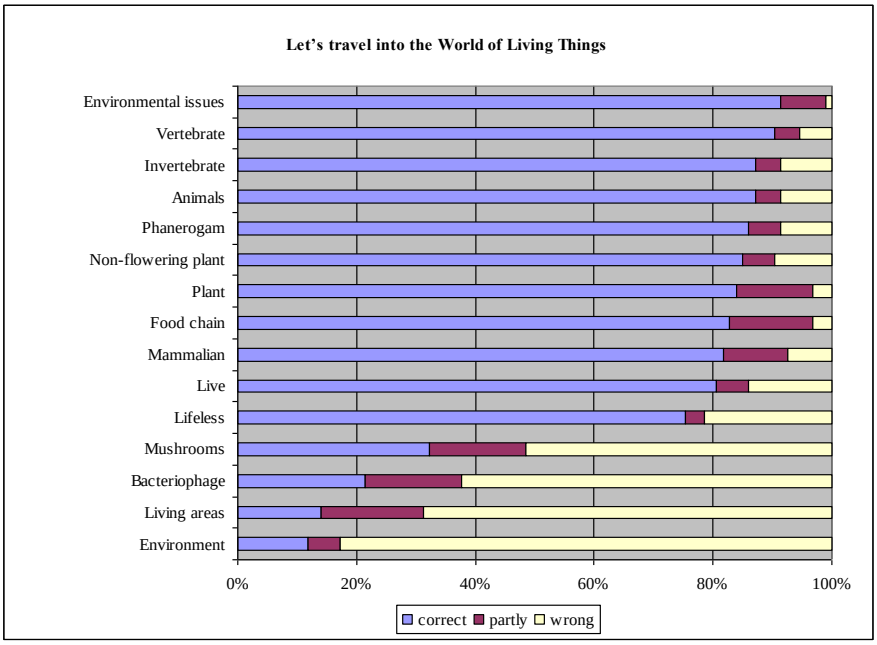

Figure 6. Findings concerning the concepts in the unit "Let's travel into the World of Living Things"

On examining Figure 6, it was found that the prospective teachers defined the concepts of flowery plants *(86%)*, environmental problems *(85%)*, flowerless plants *(84.9%)*, vertebrate *(84%)*, animals *(81%)*, invertebrate *(81%)*, living things *(80.6%)*, food chain *(77%)*, mammals *(76%)*, and plants *(78%)* correctly. Yet they could not structure the concepts of non-living things *(21.5%)*, environment *(82.8%)*, biotope *(68.8%)*, fungus *(51.6%)*, and microscopic organism *(62.4%)* clearly. However, the fact that they had problems in defining the concept of non-living things despite defining the concept of living things, that they misused the concepts of environment and biotope interchangeably, that they could not make sense of the concepts of fungus and microscopic organism demonstrated that they had misconceptions. The samples from students' answers are given below.

Fungus: "visible", "they do not cause an illness", "virus"

Animal: "Animals do not have emotions", "they do not have emotional abilities"

Food chain: "it is not always necessary for it to be alive"

Living thing: "it moves"

Plant: "Not all of them photosynthesize"

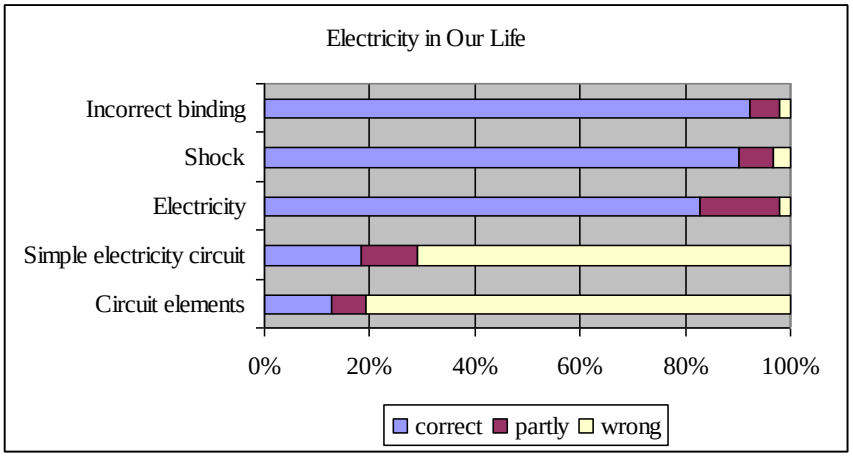

Figure 7. Findings concerning the concepts in the unit "Electricity in Our Life"

On examining Figure 7, it was found that although they defined the concepts of incorrect connection *(92.5%)*, electric shock *(90.3%)*, and electricity *(82.8%)* mostly correctly, they could not define simple electricity circuit *(71%)* and components of a circuit *(80.6%)*. This finding showed that they were lacking in the knowledge of simple electricity circuits and components of a circuit.

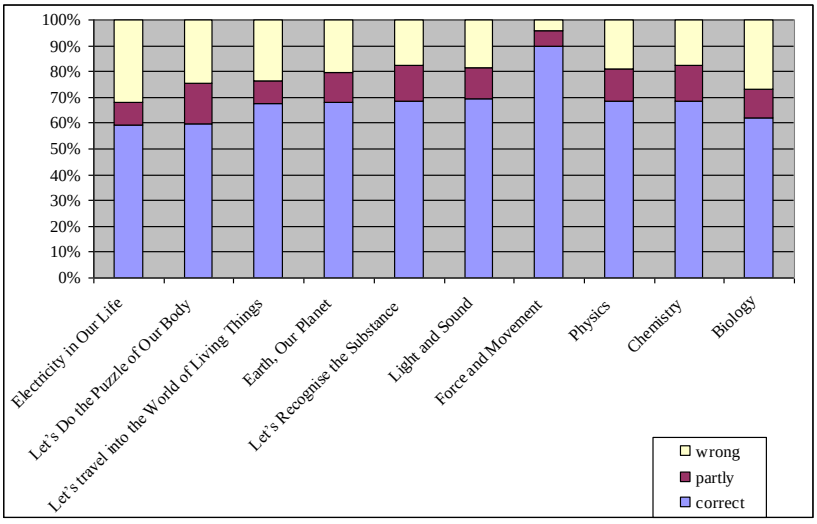

Figure 8. Findings concerning the concepts on the basis of units

When an overall evaluation was made on the basis of units, it was found that the highest number of correct answers was in the unit of Force and Movement *(90%)* whereas the lowest number was in the units of Let's Do the Puzzle of Our Body *(59.7%)* and Electricity in Our Life *(59.4%)*. The highest number of correct answers was in the concepts of physics, but the number was the lowest in biology concepts *(62.2%)*.

Table 1. The distribution of STCCS averages on the basis of gender characteristics

		n	*M*	*SD*	*t*	*p*
General	Male	35	70,85	10,381	,582	,562
	Female	58	69,46	11,627		

According to Table 1, the overall STCCS averages are not statistically significant on the basis of gender characteristics *(t=.582; p>.05).* This case shows that gender is not an influential factor in structuring the concepts.

Table 2. The distribution of STCCS averages on the basis of school of graduation

	Source	*SS*	*SD*	*MS*	*F*	*p*
General	Between Samples	188,741	3	62,914	,499	,684
	Within Samples	11224,24	89	126,115		
	Total	11412,98	92			

On studying Table 2, it is found that there are no statistically significant differences between students' achievement averages on the basis of the school of graduation *(F=.499; p>.05).*

Table 3. The correlations between STCCS averages and liking the science and technology course

		STCCS averages	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Biology achievement	r	-,220 (*)	-,140	-,160	-,284(**)	-,107	-,099	-,167	-,151
	p	,034	,181	,126	,006	,308	,345	,109	,148
	n	93	93	93	93	93	93	93	93
Chemistry achievement	r	,012	-,060	-,139	-,111	,150	,047	,214(*)	,092
	p	,908	,566	,185	,291	,150	,657	,040	,378
	n	93	93	93	93	93	93	93	93
Physics achievement	r	,026	,021	-,033	-,054	,006	-,001	,116	,198
	p	,806	,845	,752	,606	,957	,995	,268	,057
	n	93	93	93	93	93	93	93	93

*p<.05, **p<.01

A close examination of Table 3 shows that there are no correlations between the students' STCCS achievement and chemistry achievement *(r=,012; p>.05)* and physics achievement *(r=,026; p>.05)* but that there is a weak negative correlation with biology grades *(r=-,220; p>.05).* Besides, a significant negative correlation between biology achievement grade and the achievement average in unit 3 (Force and Movement) *(r=,284;p<.01)* and a significant positive correlation between chemistry achievement grade and the achievement average in unit 6 (Let's travel into the World of Living Things) are available *(r=,214;p<.01).*

Discussion

Basically, Students who newly start school encounter the concepts of physics, chemistry and biology in the third and fourth grades for the first time with Science and Technology classes. Therefore, primary school teachers play an important part at this stage. The basic knowledge that those teachers receive during their vocational training will directly affect their prospective life of teaching and their students. Besides, students qualifying to enter university start University with some misconceptions stemming from their previous education. The fact that students cannot make sense of the concepts in science based courses which they take at university and that new misconceptions occur and the previous ones are not corrected, and many other such factors may

hinder the formation of fundamental science concepts in primary education students in the future. Thus, Tery, Jones and Hurford (1985) point out that misconceptions can occur in students' methods of scientific comprehension or in their methods of organising the scientific knowledge. It was found that misconceptions arise due to not possessing prior knowledge about concepts and not considering conceptual knowledge important. White (1993) pointed out that one of the factors influential in students' understanding a concept was prior knowledge. In order to identify this case, an attempt was made to determine students' grades that they had received in the first three years of university education in physics, chemistry and biology courses- which form the basis of science and technology courses- and to determine their misconceptions as well as their efforts to make sense of concepts. Consequently, no significant differences were found between grades received from those courses and the total scores received from the scale. This case showed that the courses taken had not helped the students sufficiently to correct the misconceptions or to improve making sense of the concepts. In this study the results obtained from each unit as well as the state of primary school, high school and university students' understanding the science concepts which was available n literature were discussed as a whole. Several studies displaying that primary school, high school and university students' misconceptions are similar are available in literature (Flories, 2003; Aydoğan, Güneş and Gülçiçek, 2003). Additionally, Bisard, Aron, Francek and Nelson (1994) , in a research study on a group of students ranging from secondary school to university, found that prospective primary school teachers had carried the same misconceptions as primary school students had. Therefore, in this research, the results obtained on unit basis are handled separately along with studies on concepts available in literature.

Prospective teachers had inadequate knowledge about the concepts of digestive system, skeleton system, respiratory system, bone, contraction-relaxation, cell, organ, protein, fat and carbohydrate in the unit Let's Do the Puzzle of Our Body. It was also found that they had difficulty in understanding the concepts of muscle, joint, tissue, mineral and particularly water; and that they had misconceptions in those issues. The fact that they defined the concept of food correctly but that they used the concepts of protein, fat, carbohydrate, mineral, vitamin and water interchangeably – which was wrong- and that almost all of them could not define the concept of water correctly showed that they could not establish associations between concepts. In this respect, in several studies on biology education, it was found that many abstract concepts were available in many topics of biology and that students of differing levels of education had misconceptions about cell, animals and plants (Flories, 2003). Apart from that, there are also misconceptions in such general biology topics as cell structure and function (Marek, 1986), cell metabolism (Storey, 1991), respiration (Sander and Cramer, 1992; Sander, 1993; Songer and Mintzes, 1994; Yürük and Çakır, 2000; Tekkaya, Çapa and yılmaz, 2000), circulatory system (Stewart, Hafner and Dala, 1990; Yip, 1998), and the source of energy in plants and in animals (Konuk and Kılıç, 1999). The research results are parallel to the findings reported in literature.

Prospective teachers had inadequate knowledge about the concepts of condensation, expansion, chemical change, density, physical change, degradation, mixture, dissolution, heat, hotness, and change of state. It was found that the students used the concepts interchangeably in the cases of physical-chemical change, mixture,-solution, dissolution-melting and change of state; and that they had misconceptions in those issues. Karaer (2007) noted that prospective primary school teachers had misconceptions in the topic of substance in the concepts of pure substance, element, compound, gases, mixture, solution, melting, and dissolution. Karamustafaoğlu, Ayaş and Coştu (2002), in their research aiming to determine the misconceptions of students of primary school teaching in terms of solutions, found that those students had misconceptions in the concepts of solution, solvent and solute. In addition to that, following the literature review, it was found that the students had difficulty in understanding and misconceptions in such basic topics as heat and hotness

(Kaptan and Korkmaz, 2001; Çepni, Aydın and Ayvacı, 2000; Aydoğan, Güneş and Gülçiçek, 2003; Gümüş, et al., 2003; Thomaz, Malaquias, Valente and Antunes, 1995; Maskill, 1997; Şenocak, Sözbilir, Dilber and Taşkesenligil, 2002), substance and its states, boiling, evaporation, concentration and melting (Boz, 2005; Hatzinikita and Kaulaidis, 1997; Johnson, 1998; Çelebi, 2004; Gürses, et al., 2004; Erdem, et al., 2004; Bar and Travis, 1991; bar and Galili, 1994; Çepni, Aydın and Ayvacı, 2000; Coştu and Ayaş, 2002; Çepni, 1997; Coştu, 2006; Valanides, 2000; Pınarpaşı and Canpolat, 2003). It was also found that steam pressure was confused with atmospheric pressure, and that there were misconceptions in believing that boiling was a chemical reaction, boiling point was a constant and did not change, and that temperature would rise during boiling.

- Research reported in literature show that many misconceptions are available in relation to solutions and dissolution (Özdilek and Ergül, 2004; Prieto, Blanco and Rodriguez, 1989; Blanco and Prieto, 1997; Akgün, 2009; Koray, Akyaz and Köksal, 2007; Erdem, et al,. 2004; Taşdemir and Sarıkaya, 2005; Driver, 1985; Ebezener and Gaskell, 1995; Gödek, 1997; Horton, 2001; Köseoğlu et al., 2003; Canpolat et al., 2004). Some of the misconceptions reported in literature are: "mass (weight) is lost through dissolution, that the substance invisible when sugar dissolves in water shows that it vanishes, the dissolved sugar doesn't have mass, when salt dissolves in water a chemical change occurs, salt dissolves in water". Apart from that, studies on the relations between mass and weight, and the change of mass with gravity (Çepni, 1997; Koray, Özdemir and Tatar, 2005; Koray and Tatar, 2003) and chemical and physical change (Hesse and Anderson, 1992; Demircioğlu, Özmen and Demircioğlu, 2006; Kabapınar, Mirzalar and Adik, 2005; Ayaş and Demirbaş, 1997; Özmen, Karamustafaoğlu, Sevim and Ayaş, 2002; Sökmen, Bayram and Yılmaz, 2000; boo, 1998; Abraham, Williamson and Westbrook, 1994) are also available in literature. Misconceptions in that the state of substance changes during dissolution are also mentioned (Çalık, Ayas and Ebezener, 2005; Ebezener and Erickson, 1996; Ebezener and Gaskell, 1995). The research studies demonstrate that when students do not know the properties of substance which goes through a change, they cannot decide whether the change is physical or chemical (Ayas and Demirbaş, 1997; Özmen, Karamustafaoğlu, Sevim and Ayas, 2002). In a similar way, the research conducted by Sökmen, Bayram and Yılmaz (2000) found that the 5^{th} , 8^{th} and 9^{th} graders in primary education schools had mistakes such as "the evaporation of alcohol is a chemical change because evaporation occurs under the influence of heat", the dissolution of salt in water is a chemical change because it cannot be converted into its previous form."

The concepts that the prospective teachers had difficulty in the unit of Light and Sound were sound isolation, shadow, space, the spread of sound, light dirtiness, and light and sound. In this respect it was found that although the majority of students could not define the concepts of light and sound correctly, they were able to structure such concepts as the source of light and the source of sound correctly. This shows that they are more familiar with daily life examples related to light and sound. Besides, it was also found that the students used natural and artificial sources of light interchangeably and that they could not define solar eclipse and obscuration correctly. In a similar vein, there are research studies in literature showing that students had misconceptions in relation to some basic concepts of light in the unit of Light, which supports our findings (Cansüngü, Koray and Bal, 2002; Yıldız, 2002).

- It was found that the prospective teachers were able to define the concepts of night, day time, year, day and sun partially but that their definitions of mine, rock, the layers of earth, and the phases of the moon were incorrect and therefore were not correctly structured. Similarly, Emrahoğlu and Öztürk (2009) pointed out that the levels of prospective teachers' understanding such concepts were very low in their first year at university education, and that they had many misconceptions with regard to astronomy. Bayraktar (2009) also concluded that prospective primary school teachers'

levels of understanding the concepts about the phases of the moon were low. Apart from that, several research studies examining students' levels of understanding the concepts of astronomy, their knowledge levels and their misconceptions are also available (Büyükkasap and Samancı, 1998; Güneş, Ünsal and Ergin, 2001; Kalkan, Kalkan and Ustabaş, 2006; Ekiz and Akbaş, 2005; Şahin, 2001; Gökdere and Orbay, 2006).

It was found that although the prospective primary school teachers were able to define the concepts of electricity, electrical shock and incorrect connection in the unit of Electricity in Our Life mostly correctly, they could not define simple electrical circuits and the components of a circuit. This result shows that the students have problems in simple electrical circuits and in the components of a circuit. In their research aiming to demonstrate the 4th and 5th graders' levels of understanding the physics concepts and their misconceptions in the Science and Technology curriculum, Çepni, Aydın and Ayvacı (2000) noted that the students' level of understanding electrical current was low. In research conducted by Yürümezoğlu and Çökelez (2010), answers were sought to the question "what is happening in a simple electrical circuit which is established with a piece of conductive wire, a bulb and a battery?" and it was found that the students could not distinguish between the concepts of energy, battery and current and that they used those concepts interchangeably. Literature shows that several studies have been conducted on electricity, electrical current and simple electrical circuits from primary school to university and that students have misconceptions in those issues (Shipstone, Jung and Dupin, 1988; Driver, 1989; McDermott and Shaffer, 1992; Heler and Finley, 1992; Chambers and Andre, 1997; Lee and Law, 2001;Pardhan and Bano, 2001; Sönmez, Geban and Ertepınar, 2001; Büyükkasap, Samancı and Dikel, 2002; Sencar and Eryılmaz, 2002; Dilber and Düzgün, 2003; Küçüközer, 2003; Engelhardt vand Beichner, 2004; Ateş and Polat, 2005; Çıldır and Şen, 2006).

The prospective teachers were found to have difficulty in understanding the concepts of non-living things, environment, biotope, fungus, and microscopic organism. Besides, despite defining the concept of living things correctly, the students had problems with the concept of non-living things and used the concepts of environment and biotope interchangeably. All these finding demonstrate that they have misconceptions. In research conducted by Bahar (2003), which tried to display students' thoughts of the concept of life, it was shown that students had opinions about the properties of living and non-living things, they knew the seven basic properties of life about living things, but that those opinions varied in terms of the order and percentages, and that the students experienced some misconceptions. The fact that, even at university level, students are lacking in knowledge of seven basic life properties (respiration, nutrition, excretion, movement, growing up, stimulus-response, and reproduction) requires that the issue should be handled seriously (Bahar, Cihangir and Gözün, 2002). There are also research findings in literature reporting that students refer to living things as moving, growing up and running creatures, that they refer to things with no legs as non-living things, that they have problems in the variation and classification of living things, and that they load different meanings to animals and plants (Kinchin, 1999; Amekeder, 2002; Çardak, 2002; Yörek, Şahin, Aydın, 2009). Those findings are parallel to our findings in relation to misconceptions in the issue of living things and non-living things.

Conclusions

It was found in this research that the majority of the prospective primary school teachers were at low levels of understanding some of the basic physical, chemical and biological concepts and that they had misconceptions. The units in which the prospective teacher had the most difficulty were "Let's Do the Puzzle of Our Body" and "the Electricity in Our life" while the level of achievement was the maximum in the unit of "Force and Movement". Moreover, there were no differences between structuring the concepts on the basis of gender and of the secondary education

school of graduation. Whereas there were no correlations between the prospective teachers' STCCS achievement and chemistry and physics achievement, a significant negative correlation was found with biology achievement grades. This finding showed that those courses taken in the first three years of university education were not sufficiently influential in students' correcting their misconceptions and in their making sense of the concepts. In line with the findings, the following recommendations may be made:

The causes of misconceptions can be grouped into two: The first is the factors of course books, the teacher, and students' ignorance of previous knowledge. The second is failing to bring about the necessary conceptual change in students during the class (Yılmaz, Tekkaya, Geban and Özden, 1999). Thus, science based courses that are offered in educational faculties at undergraduate level could be designed in a manner so as to help students to structure the concepts better and to remove their misconceptions and could be enriched with concept teaching techniques (such as analogies, associating with daily life, two dimensional designs, concept maps, concept networks, meaning analysis charts, diagrams, etc.) and thus concept teaching may be performed.

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