



## Exploring Pre-Service Science Teacher Expectations on Learning Science

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### Abstract

The purpose of this study was to examine the expectations of the pre-service science (biology, chemistry, and physics) teachers about learning science on independence, coherence, concept, reality link, math link, and effort dimensions by using Science Expectations Questionnaire (SEQ) and conducting interviews with selected pre-service teachers on their questionnaire responses. The SEQ was applied to 121 pre-service science teachers in a public university. The results show that most of the pre-service science teachers had sophisticated view of learning in terms of independence and reality link dimensions; they had naïve view of learning in terms of other dimensions. Hence, teacher educators could determine pre-service science teachers' view of learning and encourage them to have more sophisticated view of learning.

### Keywords

Expectations  
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### Introduction

Epistemology is an area of philosophy and refers to the origin, nature, limits, methods, and justification of human knowledge (Hofer, 2002; Chan & Elliott, 2004). There is no definite view in order to explain the relationship between epistemology and how learner epistemological beliefs change and develop. However, the definition of epistemology includes a wide range of beliefs. Epistemological beliefs can be learner beliefs about the nature of knowledge and knowing, the certainty, the source, the justification, the acquisition, and the structure of knowledge (Duell & Schommer-Aikins, 2001; Bendixen & Rule, 2004).

In the literature, epistemological beliefs were classified by many researchers (Schommer, 1990; Hofer & Pintrich, 1997; King & Kitchener, 2004). For instance, Schommer (1990, 1994) proposed five independent dimensions which are omniscient authority, certain knowledge, simple knowledge, quick learning, and fixed ability. In the omniscient authority dimension, students admit absolute

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knowledge transmitted by authority which is textbooks, teachers, and scientists etc. Also, in the certain knowledge and simple knowledge dimensions, students believe that knowledge is simple, certain, and stable. In the quick learning dimension, students think that concepts can be learned quickly. Moreover, in the fixed ability dimension, students accept that learning ability is innate and fixed (Schommer, 1990, 1994).

Epistemological beliefs of students and teachers were also classified by researchers in terms of view of learning such as sophisticated and naïve (Schommer, 1990; Brownlee, Purdie, & Lewis, 2001; Pulmones, 2010). Sophisticated students consider that a huge amount of knowledge is evolving, some knowledge is yet to be discovered, and a very small amount of knowledge is unchanging. However, naïve students believe that a huge amount of information is certain, some knowledge is yet to be discovered, and a very small amount of knowledge is changing. Moreover, naïve teachers believe that knowledge is simple, clear and specific; knowledge resides in authorities and is certain and unchanging; concepts are learned quickly or not at all and learning ability is innate and fixed. On the other hand, sophisticated teachers believe that knowledge is complex, uncertain and tentative; knowledge can be learned gradually through reasoning processes and can be constructed by the learner (Schommer, 1990; Chan & Elliot 2004; Pulmones, 2010). Therefore, sophisticated learners or teachers could be considered as constructivist and naïve learners or teachers could be thought as traditional (Chan & Elliott, 2004).

In the literature, researchers reported that student expectations could be considered by epistemological issues. Hence, examining student expectations bring extraordinary attention to the epistemological issues (Elby, 1999; Kortemeyer 2007). In the past decades, there has been huge increase in studies regarding what students know about science and how they learn science (e.g., Qian, & Alvermann, 1995; Redish, Saul & Steinberg, 1998; Kortemeyer, 2007; Demirci, Kirbulut, Bektaş, Yalcin-Celik, Cetin-Dindar, & Kilic, 2010). Therefore, knowing what students expect from science considering by epistemological issues is necessary in the science learning-teaching process (Mistades, 2007).

Students bring their science content knowledge, attitudes, beliefs based on their own prior experiences to class. Therefore, students have expectations which are about their understanding of the process of learning science (biology, chemistry, and physics) and the structure of science knowledge (Redish et al., 1998). In this study, the definition of "expectation" was used as mentioned above. Many studies reported that student expectations from a course had a great influence on their success in learning (Schommer, 1993; Redish et al., 1998; Redish & Steinberg, 1999). If student expectations about learning science matched the experts in the field, the teaching and learning process would be very effective (Schommer, 1993; Redish et al., 1998). In order to explore students' understanding on the process of learning science and the structure of science knowledge, there have been a number of studies on the development of questionnaires, specifically in physics, (Views about Science Survey (VASS), Halloun, 1996; The Maryland Physics Expectations (MPEX) Survey, Redish et al., 1998; Epistemological Beliefs Assessment for Physical Sciences (EBAPS), White, Elby, Frederiksen & Schwartz, 1999).

The MPEX survey was developed by Redish et al. (1998) based on Hammer's (1994) study. Hammer (1994) categorized students' understanding on the nature of learning physics based on independence, coherence, and concepts dimensions. Then, Redish et al. (1998) categorized student expectations by adding three more dimensions on learning physics - independence, coherence, concepts, reality link, math link, and effort. After the validation of the survey items, they distributed the MPEX to 1500 students enrolled in introductory physics course at six colleges and universities and found that student expectations were not parallel with the expert views. They also reported that student expectations deviated much from the expert views, especially on the independence, effort, and reality link dimensions even students took physics course. In line with the findings of Redish et al.'s (1998) study, Im and Pak (2004) found that as the level of school became higher during secondary school, the gap between the expectations of students and experts became larger for independence, effort, and reality link dimensions. On the contrary to these findings, Taganahan (2003) reported that students developed mature beliefs of learning and physics knowledge on the dimensions of independence, effort, and reality link after they took introductory college physics instruction.

Henry (2001) conducted a study by using MPEX survey to examine the change in student expectations about learning physics for the students who were taught by traditional instruction and who were taught by constructivist-based instruction. He found that students who were taught by constructivist-based instruction had similar expectations with the experts on the dimensions of independence, concepts, and reality link, while neither groups differed on coherence, math link, and effort dimensions.

It is crucial to know how students' expectations were affected by the curriculum itself in order to shed light on the effects of the curriculum on students' learning and expectations (Redish et al., 1998). In the literature, there are numerous studies focused on the investigation of secondary school or university student expectations about physics learning (Redish et al., 1998; Henry, 2001; Im & Pak, 2004); however, there is no study on the exploration of the pre-service science teachers' expectations about learning science. In the literature, it is documented that epistemological views of teachers affected their efficiency of instruction (Schraw & Olafson, 2003). Therefore, in this study, we aim to examine the expectations of the pre-service teachers from biology, chemistry, and physics programs about learning science on aforementioned six dimensions by using Science Expectations Questionnaire (SEQ) adapted from MPEX survey by Demirci, et al. (2010) and conducting interviews with selected pre-service teachers on their questionnaire responses.

## Method

In this section, the sample and procedure of the study are reported. In this study, survey design based on quantitative research method is used as a method.

### *Sample*

The SEQ was applied to 121 first grade pre-service science teachers (44 pre-service biology teachers, 38 pre-service chemistry teachers, and 39 pre-service physics teachers) in a public university in Turkey. This university hosts 25000 students in 26 different majors. Faculty of education has nine departments and 27 programs with registered 10000 students in total. This study included three programs of first graders: biology education, chemistry education, and physics education. The percentages of first grade pre-service science teachers' gender based on the programs are presented in Table 1. There were 121 first grade pre-service science teachers at the three programs. All first grade pre-service science teachers take general biology, chemistry, and physics courses and related laboratory courses; in addition to these science courses they also complete "The Introduction to Education" course. In order to validate whether our understanding of the SEQ is similar to the way pre-service science teachers were read and understood, semi-structured interviews were conducted with 10% of the sample. In the interviews, pre-service science teachers were asked to interpret their responses to the items. Interviews were conducted with 10 pre-service science teachers (four female pre-service biology teachers, two female and two male pre-service chemistry teachers, and two male pre-service physics teachers).

**Table 1.** The Percentages of Pre-Service Science Teachers' Gender based on the Programs

Gender	Programs	Biology	Chemistry	Physics
Female		77	47	77
Male		23	53	23

### *Procedure*

The purpose of this study was to investigate university first year pre-service biology, chemistry and physics teachers' science expectations on learning science after they completed introductory science courses. In this study, first year pre-service science teachers were included since they just involved university science courses and it will be possible to follow them during their teacher education program. In order to determine how pre-service science teachers understand the science learning process and the structure of science knowledge, "The Science Expectations

Questionnaire" (SEQ) was used (Demirci et al., 2010). The SEQ was translated and adapted from "Maryland Physics Expectation Questionnaire" (MPEX) developed by Redish et al. (1998). The MPEX had a 5-point Likert type scale, but the questionnaire was analyzed and interpreted based on the 3-point Likert type scale - strongly disagree (1) and disagree (2) responses were tallied as "disagree", undecided (3) was tallied as "neutral", and agree (4) and strongly agree (5) responses were tallied as "agree" (Redish et al., 1998). The same procedure was used by Demirci et al. (2010), as well.

The items of SEQ were categorized in six dimensions which were independence, coherence, concepts, reality link, math link, and effort as used by Redish et al. (1998). The questionnaire item numbers based on dimensions were given in Table 2 (see Appendix for the SEQ). The definitions of each dimension are as follow:

- In the independence dimension, the items aim to seek whether students construct their understanding by themselves or they receive information by an authority source.
- Items under the coherence dimension aim to probe whether science is considered as a connected, consistent framework.
- In terms of the concept dimension, the items aim to seek whether students focus on memorizing and using formulas when learning science or whether they understand the ideas and concepts underlying science.
- In the reality link dimension, the items aim to probe whether students know that science is in close relationship to their everyday experiences.
- Items in the math link dimension aim to seek thinking on mathematics to explain information about science phenomena or to use only calculate numbers.
- In terms of items under the effort dimension, students are expected to study on their class notes and textbook carefully.

In this study, the pre-service science teachers' responses were judged considering the differences between science experts' and pre-service science teacher opinions about their expectations. The descriptive statistics was used in order to explain collected data by identifying the pre-service science teachers' expectations and the view of learning science under each related dimension.

**Table 2.** The SEQ Item Numbers based on the Six Dimensions

Dimension	Items	Dimension	Items
Independence	1, 8, 13*, 14*, 17, 27*	Effort	3, 6*, 7, 24*, 31
Coherence	12*, 15*, 16*, 21*, 29*	Math Link	2, 6*, 8*, 16, 20
Concepts	4, 19*, 26, 27*, 32	Reality link	10, 18, 22*, 25

\* Items were also asked as interview questions

The items in the SEQ were checked over by four science education experts to determine expert opinions on the items. Redish et al. (1998) stated that expert opinions on the survey represented desirable responses of their students. They defined expert as "the response that was given by a majority of experienced physics instructors who have a high concern for educational issues and a high sensitivity to students" (p. 5), since their sample consisted of university and college students in introductory calculus-based physics. Parallel to this study, we included four experts in science education (one from physics education and three from chemistry education) since we conducted this study with pre-service science teachers. Taking their responses into account, the pre-service science teachers' responses agreeing with experts' opinions indicated a sophisticated view of learning in terms of epistemological beliefs and were accepted as "favorable". On the other hand, the pre-service science teachers' contradictory responses with experts' opinions were accepted as "unfavorable", which indicated naive view of learning in terms of epistemological beliefs. The experts' responses which are favorable and similar to Redish et al. (1998) (except item 1 since the adaptation was done based on the Turkish education system) are given in Table 3. Each item in the SEQ was categorized as "favorable" and "unfavorable" based on the responses of experts with over 90% agreement for the items.

**Table 3.** The Experts' Responses of the SEQ Items

Item#	A/D*	Item#	A/D	Item#	A/D	Item#	A/D
1	A	10	D	19	D	28	D
2	D	11	A	20	D	29	D
3	A	12	D	21	D	30	A
4	D	13	D	22	D	31	A
5	A	14	D	23	D	32	A
6	A	15	D	24	D	33	D
7	A	16	D	25	A	34	A
8	D	17	D	26	A		
9	D	18	A	27	D		

\* "A" represents "Agree" and "D" represents "Disagree" responses.

After converting the 5-point Likert scale into 3-point Likert scale, the total scores were calculated between 89 (the minimum score of pre-service science teachers) and 135 (the maximum score of pre-service science teachers) based on the 3-point Likert scale - agree (4), undecided (3), disagree (2) (Redish et al., 1998).

In order to validate the consistency of our understanding of the SEQ and pre-service science teachers' interpretation on the SEQ items, semi-structured interviews were conducted by taking into consideration 10% of the sample which corresponded to 12 participants. Therefore, the pre-service science teachers' scores were divided to four categories as 89-100, 101-112, 113-124, and 125-135; one pre-service science teacher from every program was selected for each category. Unfortunately, two of the participants could not be interviewed since they did not want to be volunteered as an interviewee. Fifteen questions taking into consideration to the items 6, 9, 12, 13, 14, 15, 16, 19, 21, 22, 23, 24, 27, 28, and 29 in the SEQ were determined as interview questions in terms of students' 50% contradictory responses with the experts. Each interview was audio typed and lasted up approximately 30 minutes. The interviews were transcribed by the researchers.

## Results

In the results section, pre-service science teachers' responses to the items on the SEQ are presented based on the aforementioned six dimensions. Additionally, pre-service science teachers' interviews are given as evidences. Finally, the programs were overviewed in terms of dimensions.

### *The Independence Dimension*

In the independence dimension, the items aim to seek whether students construct their understanding by themselves or they receive information by an authority source. The independence dimension involved the items 1, 8, 13, 14, 17, and 27 on the questionnaire; for items 8, 13, 14, 17, and 27 favorable responses are "disagree" and for item 1 favorable response is "agree".

Most of the pre-service science teachers had favorably responses on this dimension with the expert group, with the percentages of 69.74, 70.98, and 57.18 for biology, chemistry, and physics pre-service teachers, respectively. Disagreeing with the item 1 indicates naïve view of learning while disagreeing with the items 8, 13, 14, 17, and 27 indicates sophisticated view of learning (Table 4).

**Table 4.** The Percentage of Pre-Service Science Teachers' Responses to the Questionnaire in terms of Programs for the Independence Dimension

The Independence Dimension	Programs	Disagree*	Undecided	Agree**
Item 1**	Biology	2.30	0.00	97.70
	Chemistry	2.60	2.60	94.80
	Physics	10.30	7.70	82.00
Item 8*, 13*, 14*, 17*, 27*	Biology	41.78	22.88	35.34
	Chemistry	47.16	14.84	38.00
	Physics	32.36	27.52	40.12

It was found that half of the participants had different opinions with the expert group on the average on the independence dimension. The greatest gap between the experts' and participants' opinions was on the item 27. For this item, 13.60% of pre-service biology teachers, 15.70% of pre-service chemistry teachers, and 0.03% of pre-service physics teachers had sophisticated view of learning. During interviews, four pre-service science teachers who had naïve view of learning stated that they supposed to understand science when they just recall scientific articles in newspapers they had read.

The item 14, "Learning physics is a matter of acquiring knowledge that is specifically located in the laws, principles, and equations given in class and/or in the textbook" was the second item which had the largest gap between the experts and participants. On this item, 51.20% of the pre-service teachers gave unfavourable response, while only 26.40% of the pre-service teachers gave favourable response. For this item, a pre-service chemistry teacher (Chemistry Student-1 (C1)) stated "*Principles and formulas should be known. They are the fundamentals of science. We even mention the rules in the laboratory. Therefore, science principles and formulas have to be known*". Although there are a few favourable responses in the SEQ for this item, during the interviews some pre-service science teachers gave favourable responses. For instance, Physics Student-1 (P1) gave a favourable response on this item and stated that "*Science is only not made of formulas. Also, it is necessary to understand the phenomena. Principles and laws come after that*". Likewise, another participant who had sophisticated view of learning stated as follows:

*I don't agree with the statement, absolutely... when you heat some water in a pan, it evaporates. While it is boiling, if you don't put a lid on a pan, that will cause energy loss. If we know this situation and still don't put the lid on the pan; this means that we couldn't apply that scientific knowledge into our daily life (C2).*

The item 13 was "My grade in this course is primarily determined by how familiar I am with the material. Insight or creativity has little to do with it". Although 41.30% of the pre-service teachers had sophisticated view of learning on this item, one of the pre-service biology teachers (Biology Student-1 (B1)) stated that "*I am not a creative type of person and I don't think creativity effect on my learning*", as a naive view of learning.

#### ***The Coherence Dimension***

In terms of the coherence dimension, according to the expert group, science should be considered as a connected, consistent framework and they were in consensus that students should disagree for all items in coherence dimension, which are 12, 15, 16, 21, and 29. The favourable responses for all these items indicate a sophisticated view of learning in terms of epistemological beliefs. On the other hand, the unfavourable responses for many items indicated naïve view of learning in terms of epistemological beliefs for coherence dimension. The pre-service science teachers mainly expressed naïve view of learning and had the lack of coherent view; this indicates that participants were not aware of the unity of science concepts and did not notice errors in their reasoning.

**Table 5.** The Percentage of Pre-Service Science Teachers' Responses to the Questionnaire in terms of Programs for the Coherence Dimension

Coherence Dimension	Program	Disagree*	Undecided	Agree
Item 12*, 15*, 16*, 21*, 29*	Biology	29.50	27.72	41.80
	Chemistry	40.02	23.70	35.78
	Physics	31.26	22.54	43.10

In this study, most of pre-service science teachers had contradictory responses with the expert group, with the percentages of 29.50, 40.02, and 31.26 for biology, chemistry, and physics pre-service teachers, respectively (see Table 5).

The interviews supported the participants' responses to the questionnaire; for instance, the item 12 was "Knowledge in science consists of many pieces of information each of which applies primarily to a specific situation." The interesting thing was that this item had the largest gap between the participants and expert group opinions. One of the pre-service chemistry teachers gave a favourable response on this item and mentioned that "*Science recounts fundamentally the same ideas but just in different views in different science branches.*" (C2). Likewise, a pre-service physics teacher responded favourably on this item and stated, "*Science courses are relevant and can also be applicable to each other because science is the life itself, you cannot fall apart them.*" (P2). On the other hand, three of the pre-service biology teachers thought that mainly science subjects in science courses were not related to each other; in other words, biology concepts were for the most part related to biology or chemistry concepts were mainly related to chemistry.

The item that had the highest rate in the favourite responses was the item 16 - "The derivations or proofs of equations in class or in the text have little to do with solving problems or with the skills I need to succeed in this course". All participants from the three programs believed that the derivations or proofs were important in understanding the science concepts. For instance, two of the pre-service chemistry teachers stated, "*The derivations can help me perceive the concepts easily.*" (C2 and C3). A pre-service biology teacher also mentioned, "*I like derive equations in class because I understand the topics more conceptually.*" (B1). A different pre-service chemistry teacher mentioned, "*When I know how an equation is derived I think that I understand the concepts better. Otherwise, I just memorize.*" (C1). On the other hand, a pre-service physics teacher thought that "*The derivation of equations is just memorizing and I do not think that this derivation thing can help me understand the concepts better.*" (P1).

The second highest in favourite response rate was the item 29, which sought for participants' view of learning and whether they realized that learning science was structuring and organizing information rather than memorizing it. The item itself was "A significant problem in this course is being able to memorize all the information I need to know." The percentages of favourable responses of pre-service biology, chemistry, and physics teachers were 43.30, 33.30, and 55.30, respectively. The sophisticated pre-service teachers realized that learning science was not memorizing the information. For instance, during the interview, a pre-service biology teacher explained as follows:

*There should not be done any promotion to memorize scientific facts in science courses because if there is memorization, that knowledge will not endure and also you cannot apply that knowledge into another situation since you did not conceptualize it. (B2).*

Additionally, a pre-service chemistry teacher stated as follows:

*Science is related to everyday life therefore you do not need to memorize anything; if we can relate science into our life, try to analyse our everyday life events and look for their scientific reason, the information that is learnt will be more enduring and we don't need to memorize any information since we relate it something we already knew. (C1).*

On the other hand, another pre-service biology teacher mentioned, "*The problem in science courses is that you should memorize a lot of information and that memorization does not always help science learning since you forgot what you memorized in a short time.*" (B1).

### ***The Concepts Dimension***

In terms of the concepts dimension, the items aim to seek whether students focus on memorizing and using formulas when learning science or whether they understand the ideas and concepts underlying science. The concept dimension involved the items 4, 19, 26, 27, and 32 on the questionnaire; "disagree" responses for items 4, 19, and 27 are favourable and "agree" responses for items 26 and 32 are favourable.

Most of pre-service teachers had unfavourably responses with expert group, with the percentages of 44.74, 48.48, and 44.59 for biology, chemistry, and physics pre-service teachers, respectively. Agreeing with the items 4, 19, and 27 indicates naïve view of learning while agreeing with the items 26 and 32 indicates sophisticated view of learning (Table 6). Within this dimension for the results on items 4, 19, and 27, pre-service teachers had contradictory responses with experts.

**Table 6.** The Percentage of Pre-Service Science Teachers' Responses to the Questionnaire in terms of Programs for the Concepts Dimension

Concepts Dimension	Programs	Disagree*	Undecided	Agree**
Item 4*, 19*, 27*	Biology	13.87	16.23	69.90
	Chemistry	11.40	14.93	73.67
	Physics	10.03	15.90	74.07
Item 26** and 32**	Biology	13.90	10.50	75,60
	Chemistry	5.20	9.25	85.55
	Physics	11.15	9.70	79.15

During the interviews, eight pre-service teachers had also showed naïve view of learning about the item 19 "The most crucial thing in solving a physics problem is finding the right equation to use". For instance, one of the pre-service chemistry teachers (C4) stated, "*We cannot solve the problem without finding the right equation. Every subject has specific formula. So, I use this formula to solve a problem. I don't need to think deeply on it.*" On other hand, only two pre-service teachers had sophisticated view about this item. For instance, a pre-service physics teacher mentioned (P2), "*The most crucial thing in solving a problem is to understand the problem... To know right equation is just memorizing. We can figure out formulas by thinking on the phenomena.*"

Additionally, for the item 27.61% of the pre-service teachers gave unfavourable response while only 13% of students gave favourable response on this dimension. Taking interview results into account, unfavourably seven pre-service science teachers thought that directly or non-directly recall was important to understand science. For instance, one pre-service chemistry teacher (C1) stated, "*If I can remember something I have read or seen, it means that I understand the subject.*" Conversely, three pre-service science teachers gave favourable responses in the interviews. One of them answered this item (C4), "*I can deal with the daily life problems with the help of science. For example, if a car is coming from the street I can decide whether I can cross the street by estimating car's speed.*"

#### **The Reality Link Dimension**

The reality link dimension involved the items 10, 18, 22, and 25 on the questionnaire. According to the experts, students should know that science is in close relationship to their everyday experiences and agreeing with the items 10 and 22 shows a naïve view of learning, while agreeing with the items 18 and 25 represents a sophisticated view of learning. Table 7 shows that most of the pre-service teachers from biology, chemistry, and physics programs responded the items of this dimension, except item 22, favourably with the percentages of 54.95, 69.05, and 70.05, respectively.

**Table 7.** The Percentages of Pre-Service Science Teachers' Responses on the Questionnaire in terms of Programs for the Reality Link Dimension

The Reality Link Dimension	Programs	Disagree**	Undecided	Agree*
Item 10** and 22**	Biology	35.50	33.40	31.10
	Chemistry	51.25	22.40	26.35
	Physics	49.80	20.30	29.90
Item 18* and 25*	Biology	6.95	18.65	74.40
	Chemistry	0.00	13.15	86.85
	Physics	4.10	5.60	90.30

The percentages of pre-service science teachers' responses on the item 22 are shown in Table 8. The results of this item are interesting since the percentage of un/favourable responses are below 50. Most of the pre-service science teachers were undecided on this item. Item 22 is "Science is related to the real world and it sometimes helps to think about the connection, but it is rarely essential for what I have to do in this course". The interviews with 10 pre-service teachers showed that while seven pre-service teachers had sophisticated view of learning about the item 22, three pre-service teachers had naïve view of learning about this item. For example, one of the chemistry pre-service teachers who had sophisticated view of learning (C2) stated that science is related to the real world:

*Science is so much related to the real life. It is in our life. I am trying to explain everything in life by using science. For example, I know why shadow is long in winter. For example, in biology, we are learning about the human body. It is so great to know about the human nature, our own nature. If I had an illness related to muscle, since I know biology, I could easily explain the reasons for this illness. Science is at everywhere in our life.*

**Table 8.** The Percentages of Pre-Service Science Teachers' Responses on the Item 22

Item 22	Disagree	Undecided	Agree
Biology	20.90	39.50	39.50
Chemistry	36.80	23.70	39.50
Physics	41.70	22.20	36.10

However, some pre-service science teachers also thought that science was not so much related to everyday life since they had difficulty in relating their science courses to real life. In the interviews, one of the pre-service biology teachers (B3) explained her ideas related to this item as follows:

*It isn't possible for me to establish relationships between every science topic I learned and my experiences in everyday life. This isn't because I don't know the science topic. This is because I don't notice and establish a relationship between science and real life.*

### The Math Link Dimension

The math link dimension involved the items 2, 6, 8, 16, and 20 on the questionnaire. Items in the math link dimension aim to seek thinking on mathematics behind scientific phenomena or just using mathematics algorithmically to explain that phenomena. Disagreeing with the items 2, 8, 16, and 20 and agreeing with the item 6 shows sophisticated view of learning.

As seen from the Table 9 for the items 2, 8, 16, and 20 pre-service teachers from biology, chemistry, and physics programs responded favourably with the percentages of 34.05, 49.90, and 37.80, respectively. In addition, for the item 6, pre-service teachers from biology, chemistry, and physics programs responded the item of this dimension favourably with the percentages of 40.90, 34.20, and 46.20, respectively. For example, item 6 was "I spend a lot of time figuring out and understanding at least some of the derivations or proofs given either in class or in the text". For the item 6, although 40% of pre-service science teachers gave the same response with experts, 33% of students selected "undecided" option. During the interviews, one of the pre-service biology teachers (B4) favourably responded this item as follows, "*Yes, I spend a lot of time. Understanding derivations is not so easy. So, in science courses, if we don't know something in detail, derivations become only memorization for us.*" Moreover, one of the pre-service physics teachers (P2) who gave unfavourable answer mentioned "*Derivations of formulas aren't so important for me and also for life. I don't care the derivations... All questions are similar with each other. If you understand some of them, you can solve the others.*"

**Table 9.** The Percentages of Pre-Service Science Teachers' Responses on the Questionnaire in terms of Programs for the Math Link Dimension

Math Link Dimension	Programs	Disagree*	Undecided	Agree**
Items 2*, 8*, 16*, 20* Item 6**	Biology	34.05	26.78	38.65
	Chemistry	49.90	16.42	32.90
	Physics	37.80	19.85	40.27
	Biology	18.20	40.90	40.90
	Chemistry	34.24	31.65	34.20
	Physics	25.62	28.24	46.20

### The Effort Dimension

This dimension was probed by the items 3, 6, 7, 24, and 31 on the questionnaire. The expert group was in agreement that students should agree on the items 3, 6, 7 and 31 of this dimension, except item 24. The experts expected students to study on their class notes and textbook carefully. Agreeing with the items 3, 6, 7, and 31 represents sophisticated view of learning, while agreeing with the item 24 shows naïve view of learning.

**Table 10.** Percentages of Pre-Service Science Teachers' Responses on the Questionnaire in terms of Programs for the Effort Dimension

The Effort Dimension	Programs	Disagree**	Undecided	Agree*
Items 3*, 6*, 7*, 31* Item 24**	Biology	9.65	17.10	73.25
	Chemistry	17.10	20.41	62.48
	Physics	15.05	19.70	65.28
	Biology	20.90	20.90	58.20
	Chemistry	36.80	10.50	52.60
	Physics	22.20	30.60	47.20

As seen from Table 10, the pre-service teachers from biology, chemistry, and physics programs had favourable responses for the items of this dimension, with the percentages of 47.08, 49.64, and 43.74, respectively. For example, item 6 was "I spend a lot of time figuring out and understanding at least some of the derivations or proofs given either in class or in the text". Interviews

showed that seven out of 10 pre-service teachers thought that it was important for them to spend a lot of time for figuring out and understanding the derivations or proofs given either in class or in the text. For example, one of the pre-service chemistry teachers who had sophisticated view of learning (C1) explained her ideas related to item 6 as follows, "*I spend much time figuring out and understanding the derivations and proofs. If I figure out the derivations and proofs, the plausibility of the formulas increases for me and I learn it better*".

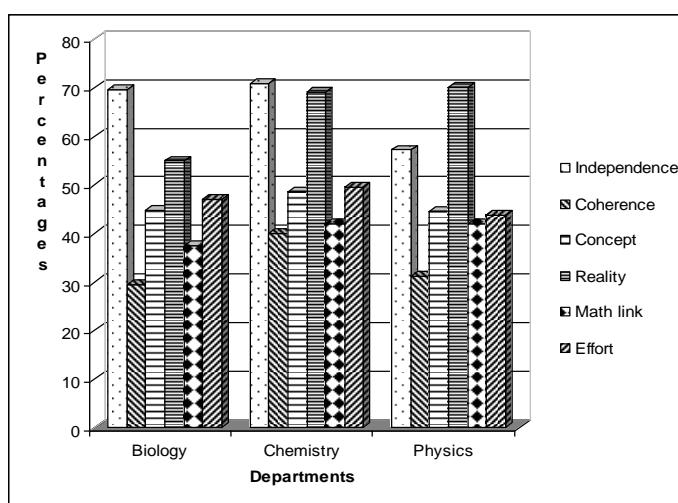
The pre-service science teachers who had naïve view of learning about item 6 mostly indicated that figuring out the derivations and proofs were not important for them since they just memorized derivations and proofs to pass the related exams. A pre-service biology teacher (B3) responded the interview question related to this item as follows, "*Since we use the outcome formula of the derivations or proofs, I don't spend too much time to understand the derivations and proofs. If a derivation or proof is an exam question, I just memorize it*".

Most of the pre-service science teachers had sophisticated view of learning for this dimension, except item 24. Item 24 was "The results of an exam don't give me any useful guidance to improve my understanding of the course material. All the learning associated with an exam is in the studying I do before it takes place". It showed the largest gap between experts and pre-service science teachers. For the item 24, 58% of pre-service biology teachers, 74% of pre-service physics teachers, and 57% of pre-service chemistry teachers had naïve view of learning. During the interviews, nine out of 10 interviewees stated that exams did not give them any useful guidance to improve their understanding of the course content since they thought that exams were only given for grading. For instance, one of the pre-service biology teachers (B4) said that due to the grading purposes, exams increased their anxiety and this resulted in rote learning, instead of meaningful learning:

*Indeed, since the main aim for exams is only grading in our courses, this creates anxiety for us and prevent us from meaningful learning. If we don't have exam anxiety, we could spend much effort to learn science better and meaningfully.*

#### ***The Overview Results of The Data on Dimensions for The Programs***

The percentages of pre-service science teachers' responses on the questionnaire in terms of programs for six dimensions were examined (see Figure 1) and it was found that there were some similarities and differences among programs regarding their epistemological view of learning for six dimensions.



**Figure 1.** The percentages of pre-service science teachers' responses on the questionnaire in terms of programs for six dimensions

For example, while most of the pre-service science teachers had sophisticated view of learning in terms of independence and reality link dimensions, they had naïve view of learning in terms of coherence, concept, effort, and math link dimensions.

- For independence dimension, the percentages of pre-service biology and chemistry teachers' responses on the questionnaire were higher than pre-service physics teachers.
- For coherence dimension, the percentages of pre-service chemistry teachers' responses were higher than pre-service biology and physics teachers. Also, pre-service biology and physics teachers had similar percentages.
- For reality link dimension, the percentages of pre-service chemistry and physics teachers' responses were higher than pre-service biology teachers.
- The pre-service science teachers had similar percentages of responses on concept, math link, and effort dimensions considering programs.

### **Discussion, Conclusion and Suggestions**

Science is not just in a class, students anyhow always experience science in their daily life. Therefore, pre-service science teachers should emphasize the importance of science education to their students and know how to make their science classes work effectively; since students' epistemological beliefs have effect on their view of learning and learning strategies. Students who have naïve view of learning in terms of epistemological beliefs tend to learn by rote; but students who have sophisticated view of learning in terms of epistemological beliefs tend to learn by constructing (Schommer, 1990; Elby, 2001; Chan & Elliot 2004; Pulmones, 2010) and sophisticated learners usually tend to be more successful than rote learners (Schommer, 1993; Redish et al., 1998; Redish & Steinberg, 1999). Since the constructivist view of learning in science classrooms leads to students to gain and promote epistemological understanding about science through active participation based on students' prior knowledge and develop an understanding of how scientific knowledge is constructed, it is associated with sophisticated view of learning (Schommer, 1990; Chan & Elliot 2004). According to the constructivist view of learning, learning outcomes depend on not only what the learner already knows but also the learning environment (Driver & Bell, 1986). Hence, the quality of science education can be improved by creating supportive learning environments in which constructivist approaches would help students to develop more sophisticated views. Since the many studies show the importance of students' expectations for their success in learning (Schommer, 1993; Redish et al., 1998; Redish & Steinberg, 1999), teacher educators should help to the learners in order to match the expectations of students with experts. Therefore, the purpose of this study was to determine the pre-service biology, chemistry, and physics teachers' epistemological view of learning; however, it is beyond the scope of this study to discuss why the pre-service science teachers differentiate on each dimension regarding programs in terms of expectations. The findings of this study indicated that most of the pre-service science teacher expectations were parallel with the experts for the independence and reality link dimensions which are contradictory to Redish et al.'s (1998) study. It seems that university introductory science courses guide students to develop more sophisticated views in terms of these dimensions. In other words, pre-service science teachers are able to construct their understanding by themselves and take responsibility for constructing it and according to pre-service science teachers involved in this study science is in close relationship to their everyday experiences. It is so promising to detect that the pre-service science teachers had favorable views in the reality link which revealed beliefs about the relationship between science and reality. Furthermore, the pre-service science teachers showed difference from the expert group on the coherence, concepts, math link, and effort dimensions. However, these results are contradictory to Redish et al. (1998) study, except the effort dimension. Most of the pre-service science teachers had naïve view on coherence, concepts, math link, and effort dimensions. There could be several reasons for this finding. The first reason could be the nature of introductory science courses at university. The unity of science concepts in the discipline itself or among different disciplines could not be emphasized in these science courses. Also, these

courses could focus on the formulas and algorithmic problem solving instead of the concept itself. Another reason could be the Turkish Education System; students are expected to listen to their teachers, solve algorithmic problems, and read their textbooks during their schooling; therefore, students consider that learning science could be achieved in this way. The other reason could be science teachers. Science teachers could not recognize their student expectations in their science courses. Hence, they could not design their courses taking into consideration student expectations.

These outcomes infer that pre-service science teachers' views of learning in terms of epistemological beliefs are not the same as experts; hence instructors should be aware of this fact and know how to help pre-service science teachers develop more sophisticated epistemological beliefs. As a way of helping pre-service science teachers to develop more sophisticated view of learning, providing constructivist learning environments may be a solution for pre-service science teachers. In this way, teacher educators not only improve their learning, but also promote development of their instructional strategies which they use in their future class. In this respect, it is important to create the constructivist learning environment rather than memorization and learning from an authority in order to let pre-service teachers express their ideas and construct their knowledge. It is also clear that students' beliefs about the nature of science (NOS) and knowledge have an important role on pre-service teachers' teaching and learning process (Redish, et, al., 1998) So, it can be also recommended that teacher education programs should aim at developing courses for pre-service science teachers including NOS, philosophy and epistemology of science during their introductory science courses. Moreover, pre-service teachers should be provided more opportunities to spend more time to make practice in the real classroom environments. Hence, teachers' epistemological beliefs are closely related to their teaching practices (Mansour, 2013).

#### ***Limitations and Directions for Future Research***

The present study has some limitations to consider. First, even if interviews were conducted with 10 pre-service science teachers to triangulate questionnaire data and gain deeper understanding of pre-service science teachers' expectations, the questionnaire data were collected as self-reported in this study. Therefore, to increase the validity of this study, different data sources could be used in further researches. Second, this study was conducted with 121 first grade pre-service science teachers in a public university in Turkey. This could cause some threats to internal validity and generalization. Further studies could be suggested conducting an extended study. Further, in the context of this study the only first grade pre-service science teachers' expectations were investigated and the other grades were not examined. A future study could include all grades of pre-service science teachers and examine the difference between the grade levels. Even a longitudinal study could be conducted that data are collected during years from same participants in order to investigate the effects of education on pre-service science teachers' expectations.

Additionally, the SEQ, which aims to determine pre-service science teachers' expectations about science courses, can be used to investigate pre-service science teachers' view of learning by instructors and researchers; therefore, deeper understanding of the science teacher education through further research could provide invaluable improvement in teaching and learning to the future development in science teacher education research.

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**Appendix – The SEQ Items**

Item#	The Science Expectation Questionnaire
1	All I need to do to understand most of the basic ideas in this course is just read the text, work most of the problems, and/or pay close attention in class.
2	All I learn from a derivation or proof of a formula is that the formula obtained is valid and that it is OK to use it in problems.
3	I go over my class notes carefully to prepare for tests in this course.
4	"Problem solving" in science basically means matching problems with facts or equations and then substituting values to get a number.
5	Learning science made me change some of my ideas about how the physical world works.
6	I spend a lot of time figuring out and understanding at least some of the derivations or proofs given either in class or in the text.
7	I read the text in detail and work through many of the examples given there.
8	In this course, I do not expect to understand equations in an intuitive sense; they must just be taken as givens.
9	The best way for me to learn science is by solving many problems rather than by carefully analysing a few in details.
10	Physical laws have little relation to what I experience in the real world.
11	A good understanding of science is necessary for me to achieve my career goals. A good grade in this course is not enough.
12	Knowledge in science consists of many pieces of information each of which applies primarily to a specific situation.
13	My grade in this course is primarily determined by how familiar I am with the material. Insight or creativity has little to do with it.
14	Learning science is a matter of acquiring knowledge that is specifically located in the laws, principles, and equations given in class and/or in the textbook.
15	In doing a science problem, if my calculation gives a result that differs significantly from what I expect, I'd have to trust the calculation.
16	The derivations or proofs of equations in class or in the text have little to do with solving problems or with the skills I need to succeed in this course.
17	Only very few specially qualified people are capable of really understanding science.
18	To understand science, I sometimes think about my personal experiences and relate them to the topic being analysed.
19	The most crucial thing in solving a science problem is finding the right equation to use.
20	If I don't remember a particular equation needed for a problem in an exam there's nothing much I can do (legally!) to come up with it.
21	If I came up with two different approaches to a problem and they gave different answers, I would not worry about it; I would just choose the answer that seemed most reasonable. (Assume the answer is not in the back of the book.)
22	Science is related to the real world and it sometimes helps to think about the connection, but it is rarely essential for what I have to do in this course.
23	The main skill I get out of this course is learning how to solve science problems.
24	The results of an exam don't give me any useful guidance to improve my understanding of the course material. All the learning associated with an exam is in the studying I do before it takes place.
25	Learning science helps me understand situations in my everyday life.
26	When I solve most exam or homework problems, I explicitly think about the concepts that underlie the problem.

- 27 "Understanding" science basically means being able to recall something you've read or been shown.
- 28 Spending a lot of time (half an hour or more) working on a problem is a waste of time. If I don't make progress quickly, I'd be better off asking someone who knows more than I do.
- 29 A significant problem in this course is being able to memorize all the information I need to know.
- 30 The main skill I get out of this course is to learn how to reason logically about the physical world.
- 31 I use the mistakes I make on homework and on exam problems as clues to what I need to do to understand the material better.
- 32 To be able to use an equation in a problem (particularly in a problem that I haven't seen before), I need to know more than what each term in the equation represents.
- 33 It is possible to pass this course (get a "C" or better) without understanding science very well.
- 34 Learning science requires that I substantially rethink, restructure, and reorganize the information that I am given in class and/or in the text.
-