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# The Analysis of High School Students' Conceptions of Learning in Different Domains

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The purpose of this study is to investigate whether or not conceptions of learning diverge in different science domains by identifying high school students' conceptions of learning in physics, chemistry and biology. The Conceptions of Learning Science (COLS) questionnaire was adapted for physics (Conceptions of Learning Physics, COLP), chemistry (Conceptions of Learning Chemistry, COLC) and biology (Conceptions of Learning Biology, COLB) firstly and they were separately administered to 361 high school students at the same time. The factor structures of each questionnaire were also analyzed by exploratory factor analysis. The differences between students' conceptions of learning in each questionnaire factors of all three domains were analyzed with paired-samples t-test. The results indicated differences in high school students' conceptions of learning physics, chemistry and biology which were identified for all seven factors except application. In general sense, it was found that students preferred higher-level conceptions of learning biology more when compared with physics and chemistry domains. Possible implications about how students prefer to view learning from a higher-level perspective rather than a lower-level perspective, especially the ones with a high mean score in physics and chemistry (such as memorizing, preparing for exam and calculating and practicing) are discussed.

*Keywords*: conceptions of learning, domain difference, culture, science domain, high school students

## INTRODUCTION

Educational researchers have conducted many studies regarding to how learning takes place and tried to identify the factors having an active role in the learning process.These factors not only affect the learning process, but also affect the learning outcomes.It was found in the studies conducted together with students' cognitive and motivational qualities (Sadi & Uyar, 2013; Demir, Öztürk & Dökme, 2012; Reyes et.al, 2011; Henning & Shulruf, 2011), learning environments (Brooks, 2010), qualities of the teacher (Rivkin et. al., 2005), attitudes towards a lesson or a topic (Stevens & Slavin, 1995), epistemological beliefs (Sadi & Dagyar, 2015; Chen & Pajares, 2010; Schommer-Aikin, 2004), approaches to learning (Chin & Brown, 2000; Cano, 2005), strategies (Rowden Quince, 2013; Li & Chun, 2012) and

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conceptions of learning (Chiou, Liang & Tsai, 2012; Tsai, 2004; Sinatra 2001; Dart et al., 2000; Pillay et al., 2000; Schommer, 1998) are also shown to be effective in the learning process and outcomes. Among these factors, conception of learning is one of the issues that are frequently taken into consideration. In general sense, conceptions of learning could be defined as the ways of learning that students prefer more during their learning process. Moreover, conceptions of learning can also be defined as the student's learning aims, activities, duties, strategies or opinions regarding the learning process (Vermunt & Vermetten, 2004). Buehl and Alexander (2001) and Tsai (2004) defined the conceptions of learning as students' school knowledge and their learning beliefs which are considered as academic epistemological beliefs. The oldest study on this topic was conducted with the university students by Saljo (1979). Saljo categorized conceptions of learning under five different categories, *increase of knowledge*, *memorizing*, *the acquisition of facts and procedures which could be retained and/or utilized in practice*, *the abstraction of meaning* and *an interpretative process aiming at an understanding of reality* depending on the interviews which he conducted with 90 college students. In a later study, Marton, Dall'Alba and Beaty (1993) added a term *changing as a person* as the sixth category. Saljo (1979) and Marton et. al. (1993) defined the first three categories (increase of knowledge, memorizing, acquisitions of facts or procedures) as passive accumulation of knowledge which are obtained externally. On the other hand, the last categories; abstraction of meaning, an interpretative process aimed at the understanding of reality and changing as a person were defined as the active acquisition, interpretation and application of knowledge obtained internally. Therefore, researchers categorized these six categories hierarchically from the most basic and simple one to the most sophisticated ones (Marton, Dall'Alba, & Beaty, 1993; Watkins & Regmi, 1992) or from the most superficial one to the most deep (Marton & Saljo, 1984). In later studies, similar categorizations were also defined (Yang & Tsai, 2010; Tsai, 2004). Furthermore, many studies revealed that conceptions of learning are related to cognitive strategies and approaches to learning (Kember, Biggs, & Leung, 2004; Burnett, Pillay, & Dart, 2003; Dart et al., 2000; Norton & Crowley, 1995). Based on the results of the study conducted by Dart et. al. (2000), it was found that the students who preferred lower level conceptions of learning such as *memorizing* and *recording* used surface strategies more (e.g. rote learning), whereas the students who preferred *understanding* or *learning as perceiving something in a different way* as their conceptions of learning used deep strategies (e.g. applying knowledge to real life). As a result, identifying students' conceptions of learning provides important insights into their learning (Tsai et. al., 2011).

A number of studies were conducted to identify general conceptions of learning (Duarte, 2007; Eklund-Myrskog, 1998; Saljo, 1979); however, the idea that conceptions of learning might be domain-specific has been discussed lately. Moreover, some studies focused how to identify high school students' conceptions of learning science, physics, biology and chemistry (Sadi & Lee, 2015; Lin & Tsai, 2013; Chiou et al. 2012; Liang & Tsai, 2010; Lee et al., 2008; Tsai & Kuo, 2008). For instance, Tsai (2004) conducted interviews with 120 university students and qualitatively divided students' conceptions of learning science into the following seven categories as *memorizing, testing, calculating and practicing tutorial problems*, *the increase in knowledge, applying, understanding and seeing in a new way*. Moreover, Tsai stated that these conceptions of learning tend to be developmental and hierarchical and the first three conceptions of learning are lower-level conceptions whereas the last four are the higher-level conceptions. However, Tsai (2004) also emphasized to the students' conceptions of learning science, so their conceptions of learning physics or biology could not be revealed through the questions referring to "science". According to abovementioned studies, conceptions of learning depend on different learning experiences in different domains which may result in different conceptions of learning. In another words, the "conceptions of learning biology" that the students preferred might be different from their "conceptions of learning physics" or from the "conceptions of learning chemistry." Chiou et. al. (2012) emphasized the need for research in more specific domains in order to examine students' conceptions of learning more in a deeper sense. However, different from the studies on general conception of learning in science, a few numbers of studies focus on students' conceptions of learning in different domains such as pure physics (Chiou et al. 2013; Hegarty-Hazel & Prosser, 1991), chemistry (Li et al. 2013; Garnett, Garnett & Hackling, 1995) and biology (Sadi & Dagyar, 2015; Chiou et al. 2012). There is no single study that focuses on and compares students' conceptions of learning especially in these three domains; physics, chemistry and biology. Consequently, this study was conducted to identify the same group of students' conceptions of learning physics, chemistry and biology and to put forth the similarities and differences in their conceptions of learning in different domains. In this way, it is expected that this study will contribute to the literature by filling an important gap.

In addition to the domain-dependent aspect of conceptions of learning, another important point that is highlighted in the literature is that students' conceptions of learning might be affected by cultural differences. For example, in his studies conducted with American and Chinese college students, Li (2001, 2003) showed that there are differences between the conceptions of learning of students from two different cultures and that conceptions of learning such as "the depth of knowledge, moral standards and the contribution of knowing to society" stand out in Chinese students' conceptions of learning. Similarly, Marton, Wen and Nagke (1996) compared Chinese and Uruguayan students' conceptions of learning and claimed that although the students from these two different cultures had similar conceptions of learning, Chinese students focused more on the learning process (i.e. continuity of learning) whereas their Uruguayan counterparts focused on the result (i.e. focusing on keeping the information permanently). When the studies conducted in Turkey are considered, there are few studies on conceptions of learning and most of them aimed to identify mostly pre-service teachers' and high school students' conceptions of learning science (Sadi & Lee, 2015; Bahcıvan & Kapucu, 2014; Dikmenli & Cardak, 2010). However, more studies that aim to identify the conceptions of learning which might be shaped depending on socio-cultural environments of the students from different regions, cities or schools are needed (Purdie, Hattie & Douglas 1996). No study compared Turkish students' conceptions of learning physics, chemistry and biology at the same time. Moreover, in the explanation of the achievement or failure of the countries in the international examinations such as PISA, in which Turkey also participates, students' level of intelligence (Herrnstein & Murray, 1994), their efforts and abilities (Tweed & Lehman 2002; Dweck 1999; Stevenson & Lee 1990), the expectations and participation of their parents (Stevenson & Stigler 1992), the research on students' beliefs and conceptions of learning may also play an important role. Therefore, it is necessary to identify Turkish students' conceptions of learning in different domains through different studies and, if necessary, to make some suggestions regarding the development of conceptions of learning.

Under the light of studies mentioned above, this study aimed to identify Turkish high school students' conceptions of learning physics, chemistry and biology and to reveal how these conceptions of learning take shape in different domains. By this way, it would be possible to analyze in which domains students had lower-level conceptions of learning and provide some suggestions for helping students to prefer more sophisticated conceptions of learning, from to higher-level conceptions of learning.

## Research questions

Most of the studies analyzed students' conceptions of learning science. However, to suit the purposes of this study, the "Conceptions of Learning Science" questionnaire was used. This questionnaire, which was developed by Lee et al. (2008) has been adapted to different domains (Chiou et al. 2013; Li, Liang & Tsai, 2013) and adapted by Sadi and Uyar (2014) to Turkish for physics, chemistry and biology in this study. Therefore, it was necessary to prepare "Conceptions of Learning Physics" (COLP), "Conceptions of Learning Chemistry" (COLC) and "Conceptions of Learning Biology" (COLB) questionnaire and to test them for their reliability and validity. Afterwards, students' conceptions of learning physics, chemistry and biology were identified by implementing these questionnaires.

Firstly, the factor structure of the COLP, COLC and COLB questionnaires were analyzed using exploratory factor analysis, and then, answers to the following questions were searched:

1. What tendencies do the high school students' conceptions of learning physics, chemistry and biology exhibit?
2. Are there any significant differences between the high school students' conceptions of learning physics, chemistry and biology?

# METHODOLOGY

This study is a quantitative one which was conducted by using a survey model. With the help of this relational survey model, it aimed to identify students' conceptions of learning in different domains and factors without forming cause-effect relationships (Karasar, 1999).

## Sample

The sample of this research consisted of 361 high school students, 174 of whom were male and 187 of them were female. All the students who participated in the study were taking physics, chemistry and biology courses simultaneously. One hundred and fifty-three students were 9th graders (42.4%), 109 students were 10th graders (30.2%), and 99 students were 11th graders (27.4%). The average age of the students was 15.8 and their ages ranged from 14 to 18.

In Turkey, students who complete the first eight years of education, have to continue to high school. On the other hand, some of the students prefer to go Anatolian high schools; science high schools, vocational high schools and some to religious high schools (İmam Hatip high school). In the current study, the target population consisted of all the 9th, 10th and 11th grade Anatolian high school students in an urban area of the Turkey. Frequently, it was extremely difficult to select a random sample because of too large population and impossible to include every individual; convenience sampling was used to choose a study sample from the target population.

## Instrument

The "Conceptions of Learning Science" (COLS) questionnaire (Lee, Johanson & Tsai, 2008) was used to identify Turkish high school students' conceptions of learning. Since, in this study, students' conceptions of learning physics, chemistry and biology were identified, "Conceptions of Learning Science" questionnaire was adapted to physics, chemistry and biology and high school students who participated in the study filled out "Conceptions of Learning Physics" (COLP), "Conceptions of Learning Chemistry" (COLC) and "Conceptions of Learning Biology"

(COLB) questionnaires. In the original questionnaire, there were 35 items measuring 7 factors. In the items under these 7 factors: 1st factor *memorizing* (5 items), 2nd factor *preparing for exams* (6 items), 3rd factor *calculating and practicing* (5 items), 4th factor *increasing one's knowledge* (5 items), 5th factor *application* (5 items), 6th factor *understanding* (4 items) and 7th factor *seeing in a new way* (5 items)

In the present study, the adapted Turkish version of "Conceptions of Learning Science" (COLS) questionnaire (Sadi & Uyar, 2014) was also revised for physics, chemistry and biology domain and tested for their reliability and validity. Every item has been modified for three domains and the students filled out all questionnaires separately. The contents of the questionnaire which was adapted for all three domains in order to identify students' conceptions of learning physics, chemistry and biology was examined by two experts in science education and information about its face validity was obtained. Following the procedure above, the questionnaires were slightly modified. The seven factors in the COLP, COLC and COLB are described below:

1. Memorizing: learning is keeping the physics/chemistry/biology knowledge in mind and remembering it when necessary.
2. Preparing for exams: learning physics/chemistry/biology is to prepare for the exam and getting high grades in physics/chemistry/biology exams.
3. Calculating and practicing: learning physics/chemistry/biology is usually solving scientific problems making quantitative calculations, practicing tutorials and manipulation of formulate and numbers.
4. Increasing one's knowledge: learning is viewed as increasing physics/chemistry/biology knowledge.
5. Application: learning physics/chemistry/biology means solving or explaining unknown questions and phenomena.
6. Understanding: learning physics/chemistry/biology is conceptualized as achieving true understanding and forming links between concepts.
7. Seeing in a new knowledge: learning physics/chemistry/biology is finding new ways of thinking and gaining new perspective.

These factors have a certain hierarchy and they are presented according to this hierarchy. The first three were categorized as "lower-level conceptions of learning" and the last four factors were categorized as "higher-level conceptions of learning" (Li, Liang & Tsai, 2013). In order to measure these factors in the questionnaire, a 5-point likert scale was developed and the answers ranged from "strongly disagree" to "strongly agree." At the same time, "exploratory factor analysis" was conducted for its construct validity.

## Data collection and analysis

The questionnaires were distributed to the Anatolian high school students with the permission of the Ministry of Education in Turkey. Every student filled out the COLP, COLC and COLB questionnaires, which were prepared for physics, chemistry and biology domains, at the same time but individually without giving personal information about themselves (anonymous). These questionnaires were completed during a class hour, which was approximately 40 minutes. Teachers and students made all required disclosures before the administration of the survey.

For the analysis of the research results, SPSS 15.0 statistical package software was used. Firstly, the answers of the all students who participated in the study to COLP, COLC and COLB questionnaires were analyzed through exploratory factor analysis. Then, descriptive statistics were conducted in order to identify the general tendencies of the students' conceptions of learning physics, chemistry and biology, and overall values were calculated for each factor of COLP, COLC and COLB. Since the groups of the sample data are not independent of one another, paired-samples t-test was conducted to identify the differences in terms of students' conceptions of learning physics, chemistry and biology domains.

## RESULTS

In order to test whether COLP, COLC and COLB questionnaires were suitable for the analysis, Kaiser-Meyer-Olkin (KMO) and Bartlett sphericity values were examined before the factor analysis. KMO coefficient is expected to be higher than 0.5 and in this way; some proof is gathered so as to whether the data obtained through the questionnaire can be modeled using factor analytical model (Field, 2000). The values for COLP, COLC and COLB were 0.873, 0.905 and 0.872, respectively and it was seen that with the values close to 1, the data were suitable for the factor analytical structure. In addition, with Bartlett sphericity test, which is ki-square statistics, the meaningfulness of the correlational matrix for the variables were tested (Büyüköztürk, 2011). According to the results of Bartlett sphericity test, ki-square ($\chi^2$) was found to be 5815.03 ($p < 0.01$) for COLP, 6825.10 ($p < 0.01$) for COLC and 4797.59 for COLB, and the null hypothesis was rejected. In other words, it was seen that the data had a normal distribution with multiple variables, and thus, suitable for the factor analysis (Cokluk, Sekercioglu & Büyüköztürk, 2010).

### Factor analysis for COLP, COLC and COLB

According to the results of exploratory factor analysis conducted to test construct validity of COLP, COLC and COLB, which are the adapted versions of COLS to identify students' conceptions of learning physics, chemistry and biology, 6$^{th}$ and 17$^{th}$ items from COLP, 6$^{th}$, 16$^{th}$ and 30$^{th}$ items from COLC and 20$^{th}$ and 21$^{st}$ items from COLB were removed, since these items loaded on more than one factor or their factor loadings were under 0.40. The results of the analysis for the remaining items are given in Table 1.

**Table 1.** COLP, COLC and COLB questionnaires factor analysis results

| Factors | COLP | COLC | COLB |
|---|---|---|---|
| Memorizing | | | |
| item1 | 0,804 | 0,793 | 0.674 |
| item2 | 0,843 | 0,830 | 0.851 |
| item3 | 0,788 | 0,815 | 0.778 |
| item4 | 0,603 | 0,681 | 0.682 |
| item5 | 0,784 | 0,764 | 0.739 |
| PE | | | |
| item6 | | | 0.525 |
| item7 | 0,759 | 0,808 | 0.782 |
| item8 | 0,807 | 0,845 | 0.813 |
| item9 | 0,657 | 0,559 | 0.587 |
| item10 | 0,724 | 0.650 | 0.613 |
| item 11 | 0,686 | 0.673 | 0.674 |
| CP | | | |

| | | | |
|---|---|---|---|
| item12 | 0.600 | 0.703 | 0.671 |
| item13 | 0.542 | 0.668 | 0.579 |
| item14 | 0.684 | 0.54 | 0.699 |
| item15 | 0.593 | 0.431 | 0.691 |
| item16 | 0.567 | | 0.605 |
| IK | | | |
| item17 | | 0.689 | 0.652 |
| item18 | 0.571 | 0.704 | 0.758 |
| item19 | 0.758 | 0.511 | 0.646 |
| item20 | 0.755 | 0.618 | |
| item21 | 0.662 | 0.661 | |
| Application | | | |
| item22 | 0.672 | 0.654 | 0.582 |
| item23 | 0.653 | 0.694 | 0.489 |
| item24 | 0.580 | 0.585 | 0.615 |
| item25 | 0.707 | 0.537 | 0.676 |
| item26 | 0.729 | 0.495 | 0.698 |
| Understanding | | | |
| item27 | 0.625 | 0.665 | 0.420 |
| tem28 | 0.479 | 0.658 | 0.440 |
| item29 | 0.475 | 0.71 | 0.580 |
| item30 | 0.735 | | 0.669 |
| SNW | | | |
| item31 | 0.789 | 0.779 | 0.718 |
| item32 | 0.777 | 0.815 | 0.771 |
| item33 | 0.739 | 0.731 | 0.730 |
| item34 | 0.703 | 0.675 | 0.731 |
| item35 | 0.449 | 0.497 | 0.544 |

*Notes: PE: preparing for exam, CP: calculating and practicing, IK: increasing one's knowledge, SNW: seeing in a new way*

As seen in Table 1, the items in all three questionnaires gathered under 7 factors whose Eigen values are over than 1, as it is in the original form of the questionnaire and the total variance explained by these factors was 60.1 %, 63.1 % and 59.5 % for COLP, COLC and COLB, respectively. In addition, with the help of Cronbach Alpha coefficient, the internal validity of the questionnaires was tested (Table 2). The Cronbach Alpha reliability coefficients of COLP, COLC and COLB were found to be 0.89, 0.92 and 0.87, respectively and for each factor, they vary from 0.63 to 0.89 (Table 2). In educational research, a reliability coefficient which is over 0.60 is considered to be acceptable and reliable (Ozdamar, 1999).

## Domain differences in conceptions of learning

In order to identify the general tendencies in high school students' conceptions of learning physics, chemistry and biology, mean values were calculated for each factor of COLP, COLC and COLB and summarized in Table 2.

**Table 2.** Mean, overall and Cronbach Alpha values for COLP, COLC and COLB

| | Factors | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Memorizing** | **PE** | **CP** | **IK** | **Application** | **Understanding** | **SNW** |
| COLP | 3.62 | 3.45 | 3.91 | 3.54 | 3.58 | 3.72 | 3.52 |
| Cronbach's alpha | 0.85 | 0.63 | 0.80 | 0.79 | 0.74 | 0.77 | 0.85 |
| overall alpha | 0.89 | | | | | | |
| COLC | 3.51 | 3.44 | 3.61 | 3.61 | 3.57 | 3.70 | 3.59 |
| Cronbach's alpha | 0.89 | 0.70 | 0.79 | 0.79 | 0.81 | 0.82 | 0.86 |
| overall alpha | 0.92 | | | | | | |
| COLB | 2.93 | 3.25 | 3.27 | 3.91 | 3.57 | 3.93 | 3.82 |
| Cronbach's alpha | 0.82 | 0.64 | 0.73 | 0.69 | 0.74 | 0.80 | 0.81 |
| overall alpha | 0.87 | | | | | | |

*Notes: PE: preparing for exams, CP: calculating and practicing, IK: increasing one's knowledge, SNW: seeing in a new way*

As seen in Table 2, students' mean scores in *memorizing* (M=3.62 for COLP and M=3.51 for COLC), *preparing for exams* (M=3.45 for COLP and M=3.44 for COLC) and *calculating and practicing* (M=3.91 for COLP and M=3.61 for COLC) in reference to physics and chemistry are higher than those in *memorizing* (M=2.93), *preparing for exams* (M=3.25) and *calculating and practicing* (M=3.27) in reference to biology. However, students' mean scores in *increasing one's knowledge* (M=3.91), *understanding* (M= 3.93) and *seeing in a new way* (M=3.82) COLB are higher than those in *increasing one's knowledge* (M=3.54 for COLP and M=3.61 for COLC), *understanding* (M=3.72 for COLP and M=3.70 for COLC) and *seeing in a new way* (M=3.52 for COLP and M=3.59 for COLC) conceptions of learning for both physics and chemistry. Students' mean scores in *application* conception of learning are close to each other in all these three domains.

In addition, paired-sample t-test was conducted in order to determine the statistical differences in conceptions of learning physics, chemistry and biology in terms of mean scores for each factor (Table 3).

**Table 3.** Paired samples t-test results of COLP, COLC and COLB

| | **Memorizing** | | **PE** | | **CP** | | **IK** | | **Application** | | **Understanding** | | **SNW** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **t-test** | **sig** | **t-test** | **sig** | **t-test** | **sig** | **t-test** | **sig** | **t-test** | **sig** | **t-test** | **sig** | **t-test** | **sig** |
| Physics Chemistry | 2.06 | .040 | .23 | .818 | 24.31 | .000 | 17.20 | .000 | .39 | .692 | 22.09 | .000 | 1.13 | .250 |
| Physics Biology | 10.63 | .000 | 8.73 | .000 | 11.14 | .000 | 11.24 | .000 | .39 | .693 | 4.16 | .000 | 5.47 | .000 |
| Chemistry Biology | 8.61 | .000 | 9.23 | .000 | 7.52 | .000 | 28.84 | .000 | .01 | .992 | 23.21 | .000 | 4.44 | .000 |

*Notes: PE: preparing for exams, CP: calculating and practicing, IK: increasing one's knowledge, SNW: seeing in a new way*

As seen in Table 3, except for *application* factor, in all six dimensions there are significant differences in students' conceptions of learning physics, chemistry and biology. In paired comparisons, there is evidence to suggest that high school students preferred *memorizing, preparing for exams* and *calculating and practicing* conceptions of learning in reference to physics ($t = 10.63$, $t = 8.73$, $t = 11.14$, $p < 0.05$ ) and chemistry ($t = 8.61$, $t = 9.23$, $t = 7.52$, $p < 0.05$) domains more than they did in biology. In addition, students' mean scores for *memorizing* and *calculating and practicing* conception of learning in physics domain ($t =2.06$, $t = 24.31$, $p < 0.05$) is significantly different and higher than those of *memorizing* and *calculating* and *practicing* conception of learning in chemistry domain. However, the *preparing for exams* factor did not show any statistical difference between the physics and chemistry domains ($t =.23$, $p > 0.05$). Furthermore, Table 3 suggests that students' mean scores in *increasing one's knowledge*, *understanding* and *seeing in a new way* are significantly different in at least one of the domains ($p < .05$). Students' mean scores of COLB in *increasing one's knowledge* , *understanding* and *seeing in a new way* are significantly different and higher than their mean scores of *increasing one's knowledge*," *understanding* and *seeing in a new way* of COLP ($t =11.24$, $t = 4.16$, $t = 5.47$, $p < 0.05$) and COLC ($t =28.84$, $t = 23.21$, $t = 4.44$, $p < 0.05$). Similarly, the mean score of COLC in *increasing one's knowledge* and *understanding* is significantly different from the mean score of COLP in *increasing one's knowledge* ($t = 17.20$, $p < 0.05$) and *understanding* ($t = 22.09$, $p < 0.05$). On the other hand, the mean difference between physics and chemistry domain was not significant with respect to *seeing in a new way* of conceptions of learning ($t = 1.13$, $p > 0.05$). In other words, high school students preferred to increase their knowledge, understand and form a new perspective in biology more than they did in physics and chemistry, whereas they preferred *increasing one's knowledge* more in chemistry than they did in physics and *understanding* more in physics than they did in chemistry.

## DISCUSSION AND CONCLUSIONS

The main purpose of this study was to investigate whether differences exist between students' conceptions of learning physics, chemistry and biology. Therefore, initially, the COLS questionnaire was modified to physics, chemistry and biology domains and exploratory factor analysis was conducted for each questionnaire. It is thought that researchers will be able to use these questionnaires to identify students' conceptions of learning physics, chemistry and biology in the future studies.

According to the findings of this research study, there are some differences in high school students' conceptions of learning depending on the domain. First, high school students prefer to learn physics and chemistry by memorizing rather than biology (Table 2 and Table 3). Moreover, they prefer *preparing for exams* and *calculating and practicing* conceptions of learning for physics and chemistry more. Some similar or different results have been provided by researchers from different countries and different cultures. As a result, although these findings differ from the results of some of the studies in the literature (Chiou, Lee & Tsai, 2013), they are still in parallel with some of them (Li, Liang & Tsai, 2013; Asikainen, Virtanen, Parpala & Lindblom-Ylanne, 2013). For example, in their quantitative study, Li, Liang and Tsai (2013) emphasized that chemistry-major college students preferred *memorizing* and *preparing for exams* conceptions of learning when learning chemistry. Likewise, in this study, it was observed that students' mean scores in *memorizing* and *preparing for exams* for learning chemistry were not low. Similar results were obtained for the same group of students' conceptions of learning physics and it was observed that these students had a tendency towards *memorizing* and *preparing for exams* conceptions of learning when learning physics. In the literature, for example, Chiou, Lee and Tsai (2013) in their study with 279 Taiwanese high school students found that the students preferred *preparing for exams* and *calculating and practicing* more than *memorizing in learning physics*. In the present study, the fact that when learning physics and chemistry, Turkish students had high mean scores in *memorizing*, *preparing for exams* and *calculating and practicing* conceptions of learning might be closely related to their learning environment. When physics and chemistry curricula in high schools are considered, it is seen that there are a lot of formulas (e.g. formulas on force and movement in physics), symbols of elements and compounds (e.g. periodical table in chemistry), equations and structures. Although science education environment in Turkey has been enriched in order to allow student interaction and relation with concrete materials because a context-based learning approach is adopted, students may still prefer lower-level conceptions of learning when learning physics and chemistry. Although the same students have not yet given up *memorizing* or *preparing for exams* and *calculating and practicing* conceptions of learning when they learn biology, they prefer them less when compared with physics and chemistry. This finding might be resulting from the fact that students may establish more links between the topics they have learned in the biology lessons and the situations they come across in daily life, that they have more opportunities to be in a learning environment suitable for learning by doing and living, or the fact that biology curriculum especially for 9$^{th}$ and 10$^{th}$ grade includes basic topics that meet students' expectations and needs. Similarly, Lin, Liang and Tsai (2015) showed that students prefer *memorizing* conception of learning biology and they have not yet given up this conception of learning, but they possessed mixed-conceptions of *memorizing* and *understanding*. In order to interpret the findings of the study in a deeper sense, it is necessary for future studies to use qualitative methods as well as quantitative methods (such as making interviews with students).

Another finding of the study is that there are significant differences in *increasing one's knowledge*, *understanding* and *seeing in new way conceptions* of learning for physics, chemistry and biology domains. Students preferred the higher-level conceptions of learning mentioned above in biology domain more than they did in physics and chemistry domains. In a general sense, the high school students participated in the study had a tendency to prefer higher-level conceptions of learning more than lower-level conceptions of learning when they learn biology. Chiou, Liang and Tsai (2012) stated that undergraduate biology major students' mean scores in higher-level conceptions of learning biology (*increasing one's knowledge*, *application*, *understanding* and *seeing in a new way*) are higher than their mean scores in lower-level conceptions of learning biology (*memorizing*, *testing*, and *calculating and practicing*) and that the students who preferred higher-level conceptions of learning used deep strategies. Similarly, Turkish high school students preferred to form links between old knowledge and newly-acquired knowledge to get more information about topics and events regarding the nature, to see the nature and living creatures from a new perspective with the help of the information they have obtained and to learn ways of explaining the events in their lives in a more logical way from the perspective of biology. The reason for this finding might be the fact that teaching strategies which allow students to use different methods and tools throughout the year, to express themselves freely and to work in cooperation with other students as well as individually are adopted in biology curriculum. However, the same students' mean scores of COLP and COLC in higher-level conceptions of learning were not as high as their COLB scores. Moreover, although the difference is not big, students' COLC mean scores in *increasing one's knowledge* are still higher than their COLP mean scores in *increasing one's knowledge*. While interpreting this kind of findings, many factors should be considered together. For example, this study provides an evidence that students had a negative attitude towards physics and the main reason for this negative attitude was the fact that they could not express physics in mathematical terms and thus they had difficulty in learning physics, even in entering physics class (Nalçacı, Akarsu & Kariper, 2011). If students do not pay attention to physics, it might not be possible for them to comprehend physics (Tekbıyık & Akdeniz, 2010). In this case, the students might adopt a conception of learning that will help them to be successful in physics exams only and this might explain their preference for lower-level COLP rather than higher-level COLP. From the same perspective, why high school students' mean scores of higher-level COLC were lower than their higher-level COLB scores can be explained. Chemistry as a branch of science examines the structure of the matters, their properties and the interaction between them. The use of chemistry knowledge in various areas today varies from understanding the structure of the living things to overcoming environmental problems (Hancer, Uludag & Yılmaz, 2007). However, if students focus only on chemical formulas, equations and symbols without realizing this quality of chemistry, they might prefer lower-level COLC when they come across questions in both school exams and national examinations which require knowledge based on memorization. Therefore, using the teaching-learning approaches mentioned in both physics and chemistry curricula effectively in the class, and integrating especially physics and chemistry topics into daily life through concrete materials and examples might cause a change in students' preferences from lower-level conceptions of learning to higher-level conceptions of learning.

Based on the findings of the study, some suggestions regarding how to lead students to prefer higher-level conceptions of learning rather than lower-level conceptions of learning, especially the ones with a high mean score in physics and chemistry (such as memorizing, preparing for exam and calculating and practicing) can be made. As the curricula for all these three domains have predicted, preparing a learning environment which allows active participation, using the teaching methods and techniques aiming at the development of science process skills, establishing a link between real life and topics covered in class by materializing them and going on education not only in classroom environment but also in laboratories and spaces outside the school might be effective in causing students to choose higher-level conceptions of learning. Besides, in order to improve the scientific importance of this study, more attempts should be made to foster students' conceptions of learning. For example, since students' conceptions of learning provides important insights into their learning (Lee et al., 2008), it is necessary to motivate students who prefer higher level conceptions of learning more to develop their physics and chemistry learning. Moreover, the results of the studies stated that students who students holding a higher-level conception of learning (such as emphasizing the understanding or seeing a new way) tended to use deep approaches to learning; however, students who report a lower-level conception of learning (such as emphasizing the memorizing or preparing for exams) tended to use surface approaches to learning (Lee et al., 2008; Dart et al., 2000). Therefore, the findings of the present study may shape insights for educators and teachers regarding how to help students engage in deep approaches and meaningful learning about physics and chemistry. Also, in relation with the findings of this study, physics and chemistry teachers should promote their students to be aware of conceptions of learning focusing to the improvement of their knowledge and experiences which are easily recallable and usable in their daily life, instead of conceptions of learning focusing on memorizing or preparing for exams. To emphasize this, teachers would prefer to do some hands-on activities with easily obtainable materials. In that respect; even though in Turkey, physics, chemistry and biology science curricula seems to promote students' thinking abilities and make them become active learner and scientifically literate, there is a big responsibility of the teachers who are the major applicators of these programs. That is why, they have to be well prepared and organized before the lectures. Science teachers should accept and use student-focused teaching approaches. To do so, pre-service teachers during their education and in-service teachers during their in-service training program should be informed and educated about constructivist view in their class to promote students active learning and assist students to construct meaningful concepts, which ensures the idea that is far away from the lower-level conceptions of learning. Moreover, the results of the study are vital for researchers, teachers and administrators to be informed about what the role of different domains on students' learning and to actively encourage their students to prefer higher level conceptions of learning.

In this study, quantitative methods were applied and students' conceptions of learning at three different domains were determined. On the other hand, to interpret the findings in detail, it is advised to use some other qualitative methods in the future studies as well. Moreover, in the current study, Turkish high school students' conceptions of learning physics, chemistry and biology were specified. Future studies might consider other knowledge domains as mathematics or engineering. Since this study was done in public Anatolian high schools being located at a provincial city of Turkey, it should be extended with different types of schools in the same city and different types of schools in various cities to generalize the findings to the larger masses. Furthermore, further research is necessary that investigates the relationships between students' conceptions of learning, epistemological beliefs, approaches to learning and self-efficacy to shed more light on ideal physics, chemistry and biology learning in Turkey.

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