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Students' Conceptions of Learning in Genetics: A Phenomenographic Research

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ABSTRACT

The purpose of this study is to identify university students' conceptions of learning in genetics. In this study, 108 students were asked to answer to open-ended questions to identify how they conceive learning genetics. The data were analyzed using phenomenographic method. According to the results, sampled university students' conceptions of learning genetics can be divided into five different categories as follows; memorization, testing, research, application and seeing in a new way. The educational system and learning environment, to which these university students enrolled, played a role in their conceptions of learning genetics. This study proposed a framework to describe the variations of the conceptions of learning and how to consist of the desired conceptions.

Keywords: Conceptions of Learning; Genetics; Phenomenographic Method; Higher Education.

INTRODUCTION

One of the primary goals of the studies carried out in the field of education is to find new ways to increase student achievement. In that respect, variety of research studies have been conducted with numerous variables as different teaching methods and techniques, identification of students' cognitive and affective qualities, increasing both teachers and students' motivation and conceptions of scientific knowledge. Another issue that has recently attracted the attention of researchers is to clarify how students are conceptualizing learning especially in different countries. It is claimed that students' approaches and conceptualization of learning have close relationship and accordingly student achievement might be affected (Entwistle & Peterson, 2004; Tsai, 2004; Chiou, Liang & Tsai, 2012; Alamdarloo, Moradi & Dehshiri, 2013). In general, conception of learning refers to ways of learning and beliefs regarding the learning period (Benson & Lor, 1999; Liang & Tsai, 2010; Chiou, Liang &Tsai, 2012). Therefore, it includes many variables such as individual's aims and strategies in learning, and efforts in the learning period (Vermunt & Vermetten, 2004; Alamdarloo, Moradi & Dehshiri, 2013). The oldest study in this field was conducted by Saljo (1979) with 90 university students. In this study, one-to-one interviews were administered to identify the students' conceptions of learning and five categories were determined based on the data analysis. These five qualitatively different conceptions of learning were a) increase of

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knowledge, b) memorization, c) acquisition of facts and procedures, d) abstraction of meaning, e) an interpretative process aimed at the understanding of reality. Marshall et.al. (1999) conducted a similar qualitative study and mentioned five categories of learning conceptions. These categories were classified as a) memorizing definitions, formulas and procedures, b) applying formulas and procedures, c) learning the rationale behind the concepts and procedures in physics, d) creating a new perspective and e) causing a change in behavior. Another phenomenographic study was conducted by Tsai (2004) with 120 university students and seven subcategories were identified for students' conceptions of science learning (memorization, exam preparation, calculation of problems and application, increase of knowledge, application, understanding and creating a different perspective). Similar to previous studies (Vermunt & Vermetten, 2004), Tsai (2004) claimed that there was a hierarchical relationship among seven categories and first three categories are "lower-level conceptions of learning" and the last four ones are "higher-level conceptions of learning." In lower-level conceptions of learning, students aimed only at acquiring knowledge, getting high scores in the exams or learning in order to solve problems. However, in higher-level conceptions of learning, there was a more sophisticated conception of learning. This includes the application of new knowledge and creation of new perspectives. Liang and Tsai (2010) conducted a quantitative study with 407 Taiwanese university students and they identified these students' opinions regarding scientific knowledge and their conceptions of learning. It was found that there was a crosslink between these two important variables. It was concluded in this study that student with sophisticated epistemological beliefs has higher-level conceptions of learning. Recently Li et. al. (2013) conducted a study with 369 university students to investigate students' conceptions of learning chemistry and the link between these conceptions and learning approaches. Learning approaches questionnaire and conceptions of learning chemistry questionnaire were administered and therefore conceptions of learning chemistry have been categorized under four categories as follows; memorization, exam preparation, calculation and application, and creating a change in the individual (a change in behavior for meaningful learning). It was also stated that students adopted in-depth learning approach have higher-level conceptions of learning (a change in behavior for meaningful learning), while students preferring superficial learning approach have lower-level conceptions of learning (memorization, test preparation, calculation and application).

Additionally, researches has also revealed that students who conceptualized learning as a qualitative view of learning (such as understanding) prefer to use deep approaches of learning; on the other hand, students who conceptualized learning as a quantitative view of learning (such as memorizing) tended to use surface approaches to learning (Dart et al., 2000). Many educators agree that deep or more meaningful learning approaches as trying to integrate the acquired knowledge were associated with better learning outcomes (Liang et al., 2010; Chin & Brown 2000, Trigwell & Prosser 1991). Since some researchers have suggested students' conceptions of learning are related to students' learning strategies, and thus their outcomes (Lederman, 1992; Tsai, 2000), this study was intended to identify university students' conceptions of learning genetics in Turkey.

In addition to abovementioned studies, there have been just a few studies to identify students' conceptions of learning and to reveal their conceptualization in Turkey. Dikmenli and Çardak (2010) conducted a qualitative study with 86 students at Biology Education department to investigate their conceptions of learning biology. Through content analysis, they divided students' conceptions of learning biology under six categories (increase of knowledge, memorization, acquisition of facts and procedures, abstraction of meaning, interpretation, causing a change in the individual (a change in behavior for meaningful learning)). These researchers claimed that students can be especially categorized under lower-

level conceptions of learning (increase of knowledge, memorization, acquisition of facts and procedures).

Analyzing the related literature, it is clear that studies usually focused on university students' conceptions of learning science or more specifically school subjects such as biology and chemistry. These studies emphasized that students' conceptions could change depending on each subject and could be categorized different categories. Therefore future research should move forward to explore conceptions of learning in more specific domains to gain a deeper understanding of how students learn in various scientific domains (Chiou et al., 2012). In particular, since university education involves different disciplines (i.e. genetics); a better understanding regarding the students in higher education by different discipline is necessary. Therefore, in this study, it is aimed to identify and then categorize the conceptions of learning genetics of the students who took genetics course before or who are still taking the course through a phenomenographic analysis. Among the research studies conducted in Turkey, any study which specifically aims to find out the conceptualization of university students' conceptions of learning genetics using the phenomenographic method was present. Therefore, this study is expected to make an important contribution to the related literature. In addition it was also suggested that there were some cultural differences in students' conceptions of learning and categorization of these conceptions (Purdie et al., 1996; Tsai, 2004; Tsai, 2006; Tsai, 2008; Tsai & Kuo, 2008). For example; it is revealed that the conceptions of learning Australian and Japanese students differ dramatically and these conceptions are differently categorized (Purdie et al., 1996; Tsai, 2004; Tsai, 2006; Tsai, 2008; Tsai & Kuo, 2008). By using qualitative research methods as phenomenography, researchers have tried to identify the effect of the cultural beliefs about learning (Boulton-Lewis et al., 2004; Richardson, 1999; Tsai, 2004).They generally stated that students' conceptions of learning could be affected by culture. Therefore, in Turkey which is a meeting point for many cultures because of its geographical position, it is aimed to carry out a qualitative study to identify how students' conception of learning genetics is categorized.

The aim of this study is to reveal how students conceptualized learning in genetics. In this way, it will be possible to understand whether these students have higher-level conceptions or lower-level conceptions and various solutions will be discussed for the students who have lower-level conceptions.

METHODOLOGY

The phenomenographic method, which is one of the qualitative data analysis methods, was utilized in this study. Aiming to reveal how events/phenomena in the environment are perceived by individuals; phenomenographic method is a widely accepted method in educational research studies (Entvistle 1997; Prosser & Trigwell 1999; Wihlborg 2004). In phenomenographic studies, researchers aim to categorize the topic, based on the data which they obtain from different individuals and they form qualitatively different categories (Tsai, 2004). However, each individual category should have a close link to the research topic. Therefore, each and every category has an informative role in identifying individuals' different conceptions (Marton & Booth, 1997). In this study, the answers that the students provided to the open-ended questions were gradually analyzed according to the phenomenographic method.

Like other qualitative studies, phenomenographic researcher provided an open account of a study's method to illustrate verification of the study. For that reason, in the present study convenient samples were selected and used to prevent biased sample and to provide a background for any attempt at applying the results in other contexts (Cope, 2004). Also, data analysis method was clearly identified. Categories of description were tried to be fully described and adequately illustrated with quotes.

a) Research Group

This study was conducted in the fall term of 2012-2013 academic years with 108 (62 female and 46 male) students from department of Biology and department of Nursing. They all taking genetics course as part of their undergraduate education. The convenience samples were used to conduct this phenomenographic study. Ages of the students were varied between 20 and 22. The major characteristics of the students were similar with respect to socio-economic status, the proportion of boys and girls in both departments. Such characteristics are taken into consideration for this study since socio-economic status and gender may affect learners' conceptions of learning (Kapucu & Bahcivan, 2014). The students who took part in the study were taken Genetics course as a must course for one semester because it was one of the departmental requirements. The same instructor gave the course by using the same teaching strategies. The course covered the definitions of several terms such as genetics, variation, and modification in addition to chromosomes, chemistry and primary functions of genes, replication, transcription, protein synthesis, gene manipulations and genetically inherited diseases.

b) Data Collection Tool

The students were asked several questions to help them to express their conceptions of learning genetics. These questions were prepared based on previous studies (Tsai, 2004). Answers to questions of "what is learning?", "how do you learn topics related to genetics?" "how would you define your learning in genetics course?" "how do you realize that you have acquired a new piece of information related to genetics?" were analyzed.

c) Data Analysis

In the present study, the students' answers to open-ended questions were analyzed in line with the aim of the phenomenographic method and the categories were formed. Firstly, the answer sheets of the students were quickly read three times. After the third reading, important sentences and some key words in each answer sheet that were relevant to students' conceptions of learning genetics were underlined. In the next step, preliminary categories were formed according to the similarities and differences in the underlined sentences and keywords (Tsai, 2004). These preliminary categories were re-examined in detail in the next stages and students' answers were located in the appropriate categories. As a result, how students conceptualize learning genetics was identified with the help of qualitatively different categories.

To exemplify how these categories were formed, it can be said that words such as "memorizing," "remembering," and "revising" were thought to be in the same conception class and thus, were located in the first category of "memorization" (Tsai, 2004). For example, the student answer below can be examined:

"There are a lot of terms in genetics. In order to remember those terms, I do a lot of revisions."

In this answer, the researcher tried to identify the student's conceptions of learning genetics by underlining the words "remember" and "revision". Another student's paper was examined below:

"When learning genetics, I generally try to memorize. Before taking the exam, I continuously read my notes and do some revision. In this way, it becomes easier for me to remember in the exam."

In this answer, the researcher underlined the words "memorize," "revision" and "remember" again and put the answers of these two students in the same category. As a result, categories of students' conceptions of learning genetics were created by taking into

consideration similar and different answers. In short, the researcher took into consideration the similarities and differences in the answers among the students rather than the similarities and differences in students individual papers and formed the categories (Marton et al. 1997, cited in Tsai, 2004).

Additionally, to check reliability in this phenomenographic study, interjudge reliability (interjudge communicability) has been used (Cope, Horan & Garner, 1997; Trigwell, Prosser & Taylor, 1994). The quotes and entire answers were given to researcher external to the study to ensure interjudge communicability. Then, the researcher outside the study independently classified the students' answers against the categories of description. Both researchers had the same idea in the creation of the categories.

FINDINGS

Through a phenomenographic analysis of students' answers to open-ended questions, five different conceptions of learning genetics were identified. If the name given to each category and the conceptions of learning in the literature overlapped, the same category name was preferred. For example, if key words in student answer sheets such as "remembering" and "revising" are widely categorized into the category of memorizing in the literature. Same key words were located into same category with the same category name in this study.

In order to explain and exemplify each category, the student answers were given in detail below. However, when choosing the answer, a number and a letter were given to each student (Tsai, 2004). Letter B was used for "Biology" students and Letter N was used for "Nursing" students. Numbers were given to each student respectively.

Memorizing: In the first category, students characterize learning genetics as "memorizing" definitions, formulas and terms. For them the purpose of learning genetics is storing all information in mind and remembering it when necessary. Students' answers are given below:

> B12: "When learning genetics, I memorize the topics and their definitions that I find important. If I revise them for several times, I remember them more easily. When studying, I always underline the terms and definitions and re-read them to remember easily."
>
> B27: "When learning genetics, I continuously try to write down what my teacher tells us. The notes that I take during the lesson are very important for me because I revise my notes for several times and try to memorize them. If I don't memorize them, I can't remember the terms and definitions."
>
> N3: "When learning genetics, I listen to my teacher very carefully and take notes of the points that I find important. Later, I memorize my notes by reading them for many times. Then, it becomes easier for me to remember in exams."
>
> N24: "In genetics course, there are a lot of terms and most of these terms are not familiar to me and learning them is very difficult. In order to keep the terms in mind, first of all, I read them several times, and then, I revise them by myself. I try to memorize until I don't need to look at the book."

The students in this category prefer to use memorization technique in order to learn genetics. Therefore, it can be concluded that the most important indicator of their conceptions of learning genetics is memorizing topics in genetics.

Testing: In the second category, students' primary goal in learning genetics is to pass the exams. They categorize conceptions of learning genetics as preparing for the exam and passing the course. The answers in this category are given below:

> B8: "To me, learning genetics means passing the exam successfully. When learning the topics, I learn the related topics by focusing on the possible exam questions."
>
> B10: "When learning genetics, my primary aim is to pass the course by getting a high grade in the exams. If there weren't any exams, I don't feel any need to learn genetics."

B18: "Learning genetics doesn't mean much to me, but I have to pass the exams since we take them as a must course. Therefore, I am learning genetics."

N22: "I am learning genetics just because it is a course. I have to answer the questions in the exams."

N36: "I cannot learn genetics well. I learn it in an exam-oriented manner. Getting a high grade in the exams is very important to me."

N48: "When learning genetics, I identify the topic that might be asked in the exam and I try to keep them in mind even if I don't understand because these topics usually appear in the exam."

Among the students who participated in this study, the ones who were categorized in this group define learning genetics as preparing for the exam and getting high grades. Moreover, they decide whether they have learned genetics or not by considering their exam results.

Researching: The third category refers to students' conceptions of learning genetics which they define as researching. The university students in this study stated that it is effective in learning genetics to do research especially on the Internet. Student answers are given below as follows;

B5: "I like learning while doing research on topics related to genetics on the Internet. I search every topic on the Internet when I find it interesting. I learn genetics by finding out about the topics that I wonder about genetics."

B22: "Learning genetics means being curious about a topic and obtaining information on that topic by doing a research."

N8: "I learn genetics through books or by doing research on the Internet. When there is a topic that I don't know, I prefer to get help from somebody or to do research on it."

N14: "I don't follow the teacher in genetics course; therefore, I can say that I learn it through the Internet. I learn by doing research with the help of books and the computer."

These university students characterized learning genetics as doing research. In order to get information about a topic related to genetics, they usually preferred doing research on the Internet.

Applying: The university students characterize conceptions of learning genetics as "application". They define the goal of learning genetics as the application of the topics related to genetics to daily life. For example:

B33: "My purpose in learning genetics is to have some information that I can apply on genetically inherited diseases that I may come across all my life."

B39: "Learning genetics is not to learn the concepts and terms, but it is to solve the problems that we may come across in daily life by using these pieces of information. Therefore, I try to apply each and every piece of information."

N66: "Especially for my subject area, learning genetics is to apply the pieces of information that I have acquired because I know that in my professional life, I will need all the information that I have learned in genetics course."

In the application category, the participants of the study believe that it is necessary to apply the acquired information and to transfer it to the daily life.

Seeing in a new way: In the last category, university students regard the conceptions of learning genetics as self-improvement by creating a new perspective. Learning genetics is seen as interpreting what is happening around them and in the nature in a different way and suggesting solutions to the problems. The students' answers are given below:

B2: "Learning genetics enable me to make different comments and provide a new perspective in some events that take place around me, especially in medical cases. As a result, I believe that I improve myself with every piece of information that I learn."

N67: "Genetics is an area which covers a lot of topics and has a link with different subject areas such as physics and chemistry. Learning genetics means improving myself in other areas at the same time and suggesting different solutions."

Although some students stated that learning genetics is important to improve themselves and creating different perspectives, it is necessary to emphasize that they are in low frequency.

Distribution of Students' Conceptions of Learning Genetics

Based on the answers provided by participating university students giving answers to the open-ended questions, five different categories were identified and each category students' conceptions of learning genetics is expressed. While naming the categories, previous studies were taken into consideration based on the related literature. Another independent researcher was also asked to contribute in stages where the similarities and differences in student papers were identified. The given answers were categorized and the frequencies of each subcategory were given in table 1.

Table 1: *Students' Conceptions of Learning Genetics (N=108) and Their Frequencies.*

Conceptions	n	f (%)
Memorizing	30	27.8
Testing	35	32.4
Researching	20	18.5
Applying	15	13.9
Seeing in a new way	8	7.4

It is clear from Table 1 that, students' conceptions of learning genetics were heavily distributed in the category of "testing" (32.4 %). The next frequent one was "memorizing" for 30 students (27.8 %). Some of the students (18.5 %) stated that they learn by "researching". However, 13.9 % of the students viewed learning genetics as "applying" and few students perceived learning genetics as 'seeing in a new way' (7.4 %).

DISCUSSION and CONCLUSION

This study was conducted to explore university students' conceptions of learning, particularly toward the subject of genetics by using phenomenographic method. Many students who participated in the study conceive learning genetics in the categories of "testing", "memorizing" and "researching", but fewer students has "applying" and "seeing in a new way" as their conceptions of learning genetics. In fact, this result shows that the deep-rooted structure in the education system which has been expected to overcome for many years but has not been changed yet. The reason is that the conceptions of learning by "memorizing" and "testing" has not changed. However, although they are few in number, there are still some students who prefer to learn by applying the information they have acquired and by improving themselves.

According to the results, 18.5 % of the students learn genetics by "researching" (Table 1). In fact, this category has not been mentioned in the previous studies in the literature. The lecturing style of the lecturers at universities might have an effect on the emergence of this new category because it is known that educational environments have an effect on students' conceptions of learning (Cano, 2005; Chin & Brown, 2000; Trigwell, Prosser & Waterhouse, 1999). If the lecturers ask students to do some research on the topic and then make a presentation in class, students might also prefer learning by "researching." This new category might have emerged as the direct result of the educational environment. This study reveals that especially the participants of this study prefer to do research through the Internet. They prefer doing research using a computer rather than using written sources. In future studies, this issue might be chosen as the research topic to discuss its reasons and results. Another

striking finding of the study is that the conception of "testing" is the category with the highest frequency among the all categories. Nearly 32% of the students expressed their conception of learning genetics as "testing." This result is not so surprising for Turkey because this country is described as "a country of exams" (Yıldırım, 2010), where students take a lot of exams during their education life. They also have to take another exam to start working at public institutions after they graduate from high school/university. For example, in Turkey, in the new system regarding the transfer to secondary education (for students to be able to make a preference list for high school), from 2013-2014 academic year on, one of the exams given by the teacher for 6 basic subjects in 8th grade during a semester will a centralized examination. In other words, every student has to take 2 examinations prepared by the Ministry of National Education (MoNE) per year. As a result, they will be able to make their preferences for the following year's high school (Anatolian, science, vocational and religious high schools) depending on their yearly grade average. In the last year of their high school education, they have to take Higher Education Examination (HEE) and Undergraduate Placement Examination (UPE) in order to enroll a university. Every year, about two million people apply for these exams and these students are expected to get high grades and gain the right to get education at the desired university and desired department. After they complete their undergraduate education, if they want to work at public institutions as a civil servant, they also have to get high grades in Civil Servant Selection Examination (CSSE) and to gain the right to apply for the related vocational positions. Therefore, in a country where there is such an exam load mentioned above, it is not surprising that students have a conception of learning in the category of "testing" In addition, since getting high grades in the exams is something that pleases the teachers and the parents, it is natural for these students to have the conception of "testing." However, Tsai (2004) in his study highlighted that the conception of "testing" is a quantitative view of learning. Quantitative learning refers to the action of keeping or saving up new and correct pieces of information in mind. In other words, the students in this study perceive genetics as a separate learning area and memorize the concepts, terms and definitions without forming a lot of links because they aim to get a high grade in the exam. On the other hand, 27.8 % of the students participated in the study has "memorizing" as their conception of learning genetics. In order to change this familiar learning style (memorizing), which has a long tradition in the education system, there are revised curricula which have been implemented gradually since 2004 in primary and secondary education. Unfortunately, these curricula which are based on the constructivist philosophy have not yet implemented at the desired level. This might be the reason why the conception of "memorizing" still has a high frequency. In order for a conception of learning to change from "lower level conceptions of learning" to "higher level conceptions of learning" (Dart et al., 2000; Tsai, 2004; Ferla, Valcke, & Schuyten, 2008; Lee et al., 2008; Edmunds & Richardson, 2009), it is necessary for teachers to completely change their teaching style from traditional teaching to constructivist teaching and to educate their students accordingly. According to Trigwell, Prosser and Waterhouse (1999), if teachers adopt the content-oriented view of teaching and use traditional methods, students perceive learning as only acquiring information and keeping that information in memory. However, at this point it is necessary to mention that if this study was conducted in secondary or high school level, the number of the conception of "memorizing" in learning genetics might not be so high. Depending on the change in the learning environment, different results might be obtained. Since this kind of a study is necessary for Turkey, this might be an important research topic for future studies.

Another conclusion that can be drawn from the results of the study is that 18.5% of the students have "applying" as the conception of learning, while 7.4% have the conception of "seeing in a new way." As it was stated in the previous studies, these two conceptions of learning are called "qualitative view of learning" (Marton et al. 1993, 1997 cited in Tsai,

2004). The students achieve meaningful learning by forming a link between the new information they have acquired and the existing information. Learning is not only keeping the information in mind, but it is also using it in different situations. According to Dart et. al. (2000), if students adopt a qualitative conception of learning (such as seeing in a new way and applying), they tend to have deep approaches to learning. Tsai (2004) claimed that there is a link between the qualitative view of learning and constructivist view. From this perspective, for example, the constructivist view of dealing with the curriculum and the lessons thoroughly instead of dealing with them in a superficial manner (Brooks & Brooks 1993, cited in Tsai, 2004) and of the application of the acquired information (Tsai, 2001) are included in scope of the qualitative view of learning (Tsai, 2004). Therefore, educators, guidance teachers and teachers should internalize and implement the constructivist approach in educational settings very well in order to create qualitative view of learning instead of quantitative view of learning. Both the educators and the students have a lot of important responsibilities in all grade levels in Turkey. Administrators, teachers, experts and curriculum developers should spend more efforts to change the students' lower-level conceptions of learning such as "memorizing" and "preparing for the exam." Fully implementing the constructivist approach in class might be the most important stage of this change.

In this study, as mentioned above, a new category named "researching" was formed. Depending on the students' answers, this category was defined as accessing information only by researching. The category of "researching" was not regarded as a higher-level conception of learning which requires the discovery of new information. Therefore, it was defined as merely obtaining information and was regarded as quantitative view of learning together with "memorizing" and "testing."

In short, in this study, five categories of conceptions of learning genetics (memorizing, testing, researching, applying and seeing in a new way) for sampled university students were identified. The subject of genetics which has a close link with other subjects (biochemistry, chemistry, general biology and health) was chosen and the study was conducted on this subject. Since conception of learning is domain dependent (Buehl & Alexander, 2001; Hofer, 2000; Tsai, 2004; Lee et al, 2008; Chiou et al. , 2012, cited in Li, Liang & Tsai, 2013), it does not mean that the same categories will be identified in conceptions of learning in other subjects. As a result, it is necessary to identify the students' conceptions of learning in other subjects such as biochemistry, chemistry, physics and mathematics to form the categories. Also, the effect of departments on the conceptions of learning should be researched in future studies. In addition, there might be differences in the identification of conceptions of learning at high school. New studies would be conducted for different grade levels. Moreover, this study was conducted using phenomenographic method. After the analysis of the answers to open-ended questions, the categories were formed. The study might be repeated by making interviews. Students' conceptions of learning might be identified by using quantitative research methods as well as qualitative research methods.

REFERENCES

Alamdarloo, G. , Moradi, S. & Dehshiri, G. (2013). The Relationship between students' conceptions of learning and their academic achievement. Psychology, 4, 44-49. doi: 10.4236/psych.2013.41006.

Benson, P. & Lor, W. (1999). Conceptions of language and language learning. *System*, 27(4), 459-472.

Brooks, J.G. and Brooks, M.G. (1993). *The Case for Constructivist Classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Buehl, M.M., & Alexander, P.A. (2001). Beliefs about academic knowledge. *Educational Psychology Review*, 13, 325–351.

Cano, F.(2005). Epistemological beliefs and approaches to learning: their change through secondary school and their influence on academic performance. *British Journal of Educational Psychology*, 75 (2), 203–221.

Cope, C. (2004) Ensuring validity and reliability in phenomenographic research using the analytical structure of awareness. *Qualitative Research Journal*, 4(2): 5–18.

Cope C.J., Horan, P. and Garner, M. (1997). Conceptions of an information system and their use in teaching about IS. *Informing Science Journal*, 1(1), 7-19.

Chin, C.,& Brown, D. E.(2000). Learning in Science: A Comparison of Deep and Surface Approaches. *Journal of Research in Science Teaching*, 37 (2), 109–138.

Chiou, G.L., Liang, J.C., & Tsai,C.C. (2012), Undergraduate students' conceptions of and approaches to learning in biology: a study of their structural models and gender differences. *Int. J. Sci. Educ*., 34, 167–195.

Dart, B.C., Burnett, P.C., Purdie, N., Boulton-Lewis, G., Campbell, J. & Smith, D. (2000). Students' conceptions of learning, the classroom environment, and approaches to learning. *Journal of Educational Research*, 93, 262–270.

Dikmenli, M., & Cardak, O. (2010). A study on biology student teachers' conceptions of learning. *Procedia Social and Behavioral Sciences*, 2, 933–937. DOI: 10.1080/09500690701191425.

Edmunds, R., & Richardson, J. T. E. (2009). Conceptions of learning, approaches to studying and personal development in UK higher education. *British Journal of Educational Psychology*, 79, 295−309. doi:10.1348/000709908X368866.

Entwistle, N. (1997). Introduction: Phenomenography in higher education. *Higher Educ. Res. Dev*. ,16, 127.

Entwistle, N., & Peterson, E. R. (2004). *Learning styles and approaches to studying*. In C. Spielberger (Ed.), Encyclopedia of applied psychology (pp. 537−542). New York: Academic Press.

Ferla, J., Valcke, M., & Schuyten, G. (2008). Relationships between student cognitions and their effects on study strategies. *Learning and Individual Differences*, 18(2), 271-278.

Hofer, B.K. (2000). Dimensionality and disciplinary differences in personal epistemology. *Contemporary Educational Psychology*, 25, 378–405

Kapucu, S., & Bahçivan, E. (2014). The Differences in senior Turkish pre-service elementary science teachers' conceptions of learning science with respect to gender and socio-economic status. *International Online Journal of Educational Sciences*, 6 (1), 41-48.

Lederman, N.G. (1992). Students' and teachers' conceptions of the nature of science: a review of the research. *Journal of Research in Science Teaching*, 29, 331–359.

Lee M.-H., Johanson, R. E., & Tsai, C.-C. (2008). Exploring Taiwanese high school students' conceptions of and approaches to learning science through a structural equation modeling analysis. *Science Education*, 92, 191-220.

Li, W.T., Liang, J.C., & Tsai, C.C. (2013). Relational analysis of college chemistry-major students' conceptions of and approaches to learning chemistry. *Chemistry Education Research and Practice*, 14, 555-565. doi: 10.1039/c3rp00034f

Liang, J. C., & Tsai C. C. (2010). Relational analysis of college science-major students' epistemological beliefs toward science and conceptions of learning science. *Int. J. Sci. Educ.*, 32, 2273–2289.

Vermunt, J. D.,& Vermetten, Y. J. (2004). Patterns in student learning: relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review*, 16 (4), 359-383

Marshall, D., Summer, M., & Woolnough, B. (1999). Students' conceptions of learning in an engineering context. *Higher Education*, 38, 291-309.

Marton, F. & Booth, S. (1997). *Learning and awareness*. Hillsdale, NJ: Lawrence Erlbaum Ass.

Prosser, M. and Trigwell, K. (1999). *Understanding teaching and learning: The Experience in Higher Education*. Buckingham: Open University Press.

Purdie, N., Hattie, J., & Douglas, G. (1996). Student conceptions of learning and their use of self-regulated learning strategies: a cross-cultural comparison. *Journal of Educational Psychology*, 88, 87–100.

Saljo, R. (1979). Learning in the learner's perspective 1. Some commonsense conceptions. Gothenburg: Institute of Education, University of Gothenburg.

Trigwell, K., & Prosser, M. (1991). Improving the quality of student learning: the influence of learning context and student approaches to learning on learning outcomes. *Higher Education*, 22(3), 251-266.

Trigwell, K., Prosser, M. & Taylor, P. (1994). Qualitative differences in approaches to teaching first year university science. *Higher Education* , 27, 75-84. doi: 10.1007/BF01383761

Trigwell, K., Prosser, M., & Waterhouse, F. (1999). Relations between teachers' approaches to teaching and students' approaches to learning. *Higher Education*, 37(1), 57-70.

Tsai, C.-C. (2000). The effects of STS-oriented instruction on female tenth graders' cognitive structure outcomes and the role of student scientific epistemological beliefs. *International Journal of Science Education*, 22, 1099–1115.

Tsai, C.-C. (2001). The interpretation construction design model for teaching science and its applications to Internet-based instruction in Taiwan. *International Journal of Educational Development*, 21, 401–415.

Tsai,C.C (2004) Conceptions of learning science among high school students in Taiwan: a phenomenographic analysis. International Journal of Science Education, 26 (14), 1733-1750. doi: 10.1080/0950069042000230776

Tsai, C.C. (2006).Biological knowledge is more tentative than physics knowledge': Taiwan high school adolescents' views about the nature of biology and physics. *Adolescence*, 41, 691–703.

Tsai, C. C., & Kuo, Pi-Chu. (2008). Cram School Students' Conceptions of Learning and Learning Science in Taiwan. *International Journal of Science Education*, 30:3, 353-375,

Wihlborg, M. (2004). Student nurses' conceptions of internationalism in general and as an essential part of Swedish nurses' education. *Higher Educ. Res. Dev.*, 23, 433.

Yildirim, C. (2010). Turkey's education system leads nowhere, professor says. Turkish Daily News 01—23—2010. ttp://www.hurriyetdailynews.com/default.aspx?pageid=438&n=0119104235670 Accessed 21 October 2013.