JOURNAL OF EDUCATIONAL AND INSTRUCTIONAL STUDIES
IN THE WORLD
February 2016, Volume: 6 Issue: 1 Article: 03 ISSN: 2146-7463

CONCEPTUAL UNDERSTANDINGS OF SEVENTH GRADE GIFTED STUDENTS REGARDING SEVERAL SITUATIONS INVOLVING CHEMICAL CHANGES

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Abstract
Concept teaching in gifted children comes out as an issue which needs to be focused on. The main institutions which support those children in addition to their school life in Turkey are Science and Art Centers (SACs). Thus, the studies conducted in SACs with gifted children are significant. In this study, it is aimed to investigate the conceptual understandings of middle school 7th grade gifted students regarding several situations involving chemical changes from daily life. The study was conducted with 37 students who attended 2 different SACs in the western part of Turkey in spring term, in 2014-2015 academic year. In data gathering, a test which consisted of 3 open ended questions developed by the researchers was utilized. Collected data was analyzed via content analysis and quantified by calculating frequencies. The findings of the study are expected to contribute to the educators by providing ideas related to the design of teaching activities of those students.

Keywords: Chemical change, daily life, SACs.

INTRODUCTION

Despite being ignored in Turkey for long years and not gaining any significant results, it is a promising situation that gifted education receives importance again and the society becomes aware of it. Correct perception of those children is very important in both their families and in the schools where they receive education. The opinions and believes which involve misconceptions and bias such as “They need less teacher attention since they learn rapidly and without any directions”, “They are high level students who demonstrate good performances during the exams”, “They need no assistance for their studies or homework because they can cope with them all by themselves” (“Giftedness - Myths & Misconceptions”, n.d.) harm those children. On the contrary to those ideas, gifted children require special education and approaches which are different from those of their peers (Baykoç, 2011: 366-369; Sak, 2014a: 133) because those individuals are not ordinary (Sak, 2014: 3). As indicated by Sak (2014b), those students’ education cannot be conducted via riddles, puzzles or mind games.

Gifted Students and Science Education

When the studies in that field are examined, concept teaching in gifted students becomes clear as an issue which needs to be concentrated on. However, it has been seen that especially most of the theses researches focus on psychological factors and there is a vacancy in the field of teaching (Ürek and Arıkıl, 2013). When the conducted studies are examined in terms of science teaching in gifted students, it has been determined that

there are few studies related to limited subjects in science teaching (Çakır, 2011; Çalıkoğlu, 2014; Doğan, 2007; Kanlı, 2008; Vural, 2010). It has also been asserted by Vural (2010) that there is a vacancy in the literature related to the studies aiming concept teaching in gifted students.

Science and Art Centre Model

In Turkey, the major institutions which support gifted students' education in addition to their school education are Science and Art Centers (SACs) which was firstly founded as Yasemin Karakaya SAC in Ankara in 1995 and today they have been located in more than 60 provinces of Turkey with a number over 70. Those children seize the opportunity of studying and producing regarding their own interests and abilities with their peers who are similar to themselves in SACs while they experience the process of integration with the society in their schools (Baykoç, 2011: 374-375). Thus, the studies related to gifted children conducted in SACs are of great importance.

The selection procedure of the students to the SACs firstly begins with diagnostics of giftedness. Then, in the following years, selected students are educated via applications such as adaptation, support, realizing individual abilities, developing special abilities and project groups which are conducted with small number of gifted students based on investigation and projects. The students who have been identified as "gifted" take this education from the expert teachers in SACs in the periods of time during which students do not go to their school. Those students' programs in SACs are prepared especially properly for each of them. The activities which enrich the abilities of the students are achieved in or out of the school semesters with the help of projects supported by the Scientific and Technological Research Council of Turkey, nature camps or cooperative researches with universities via the teachers in SACs.

The Significance of Conceptual Understandings in Science Education

In order to design appropriate activities for students, it is required to investigate what those students know – their pre-knowledge related to the concepts which are wanted to given to them. Knowing what students know correctly and what they know partially or incorrectly provide clues for teachers. In this field, there is a huge amount of studies conducted with average intellectual level students in various subjects about conceptual understandings. However, there are not sufficient studies conducted with gifted students studying in SACs which aim to conduct enrichment activities for them. The activities which are conducted in those institutions are directly student centered. Becoming aware of the misconceptions and insufficient knowledge that might be in students and not causing new misconceptions during the activities are crucial for the teachers because when the students assimilate new knowledge on their present knowledge, this situation might bring about various unintended consequences in teaching (Talanquar, 2006). That point requires the examination of conceptual understanding levels of the students according to the subject matter.

As a result of the studies, unfortunately, it has been determined that generally the teachers do not analyze and examine the opinions of the students related to the natural phenomenon (Talanquar, 2006). In addition, again mostly teachers are not aware of the determined misconceptions or they ignore them during teaching (Gabel, 1999). When the examination of the conceptual understandings of the students about various scientific cases are considered in terms of the education provided by SACs, it will be for the favor of gifted students' science education and contribute to the conceptual understandings of those children.

Concept Teaching Studies Conducted in Science and Art Centers in Turkey

In the literature, there are a few studies which were conducted with gifted students from SACs on the subject of concept teaching in science education (Doğan, 2007; Vural, 2010). Doğan (2007) conducted a study based on case study methodology with the students who were on average intellectual level and who were determined to be gifted in the 5^{th}, 6^{th} and 7^{th} grade levels. In this study, it was aimed to specify the understanding levels and misconceptions of the students related to the concepts of "evaporation", "condensation" and "boiling". As a result of the study, it was seen that the level of attainment of the objectives in the teaching program related to the concepts of "evaporation", "condensation" and "boiling" by the students was the highest for the macroscopic properties of matter whereas this level was lower for the microscopic properties of matter and it was the lowest for the use of those concepts in the explanation of daily life events. Yet, one of the fundamental purposes of science education is to connect theoretical knowledge to the daily life issues. In addition,

differences were identified in the understandings of elementary 5th, 6th and 7th grade gifted and non-gifted students (Doğan, 2007). This consequence indicates the essence of development of activities and teaching programs especially for gifted students.

Vural (2010) made a study based on action research with 6th grade level gifted students. The researcher firstly investigated the conceptual understanding levels and misconceptions of the students about the concepts of "melting", "freezing" "evaporation", "boiling" and "condensation". Then, teaching activities which were prepared considering constructivist approach were implemented to the students to check whether the activities worked or not. In that study, it was found that the students possessed several misconceptions and insufficient knowledge as indicated in the literature previously. The activities implemented to the students helped to improve their understanding levels although they showed a limited change in some situations. Also, it was determined that students could make high level interpretations for the new knowledge that they encountered in pursuant of their giftedness and they did not experience much difficulty at this aspect.

Çakır (2011) who conducted a research based on case study methodology investigated the mental models of gifted students related to the concepts of "conductors" and "insulators". The consequences of this study demonstrated that the mental models of gifted students were clear and generally compatible with conceptual models. Therefore, it was concluded that the validity of their mental models were high and open to change. Also, it was asserted that those students could make correct predictions with the help of those mental models and construct better mental models when they supported their predictions with the observations. In another study, it was determined that different grade level students possessed better approaches and attitudes towards science when compared to their average intellectual level peers (Ürek, 2012; Ürek and Dolu, 2013). Those results one again approve the necessity and benefit of the activities which are especially developed considering gifted students. The reason why gifted students should be educated with an approach that is different from those of non-gifted students comes out.

Chemistry in Daily Life

The subjects related to chemistry in primary and middle school level are provided to the students in terms of science and technology course in Turkey. One of the aims of science education given to the students is about the utilization and application of the concepts (Çepni, 2011: 9). At this aspect, one of the aims is defined as "Seeing the utilization of scientific concepts in daily life" (Çepni, 2011: 9). However, in a study which was conducted with non-gifted 8th grade level students, it was found that more than half of the students who attended the study failed to relate scientific concepts with daily life (Yiğit, Devecioğlu and Ayvacı, 2004). Additionally, in the same study, it was also found that only one third of the participants could relate chemistry concepts correctly to the daily life. Similarly, studies which were conducted with teacher candidates on relating their chemistry knowledge with daily life reported that they experienced difficulties at that point although being in university level (Özmen, 2003; Yadigaroğlu and Demircioğlu, 2012). Unfortunately, those results indicate us that the concepts are kept in students' minds based on memorization and the students could not notice their place in daily life issues.

When the aforementioned research subjects are considered in terms of gifted students' education, it is seen that there is a gap in this field which needs to be focused on. It can be concluded that chemistry knowledge constitutes an important dimension at that point because a previously conducted study reported that chemistry was the mostly reflected science branch on the drawings of the students when both gifted and non-gifted different grade level students were asked to draw a picture of science (Ürek and Arıkıl, 2011). The researchers highlight the significance of teaching relevant chemistry and they attribute various problems in chemistry education to not teaching chemistry relevantly (Holbrook, 2005; Eilks and Hofstein, 2015: 1).

The Aim and Significance of the Study

The aim of this study is to investigate how 7th grade level students who are determined to be gifted and educated via SACs understand various situations encountered in daily life involving chemical changes conceptually.

In the literature, no such studies conducted previously have been encountered by the researchers. At this respect, the study is thought to be original. Also, the findings of the study are expected to supply clues for educators in terms of designing teaching activities for gifted students. When the gaps related to the researches in gifted students' education are taken into consideration, it is clear that all the studies conducted will make contributions to this field as indicated previously by Ercan (2013). So, this study is important.

Research Questions

In the context of this study, the following questions are intended to answer related to the middle school 7th grade level gifted students who attend SACs:

1. How is the conceptual understanding of the students related to the situation involving the concepts of "chemical change" and "sun light"?
2. How is the conceptual understanding of the students related to the situation involving the concepts of "chemical change" and "precaution"?
3. How is the conceptual understanding of the students related to the situation involving the concepts of "chemical change" and "structure of matter"?

METHODOLOGY

Study Design

The present study is based on case study survey model. In case study survey model, which is one of the survey designs, it is aimed to reach a judgment upon a unit of the universe by examining this definite unit (such as an individual, a family, a school) and by determining its relationships with itself and its environment in depth and width (Karasar, 2008: 86). Also, it has been indicated that most of the case study survey models are qualitative researches and they have been reported to provide more detailed and accurate information when compared to the general surveys (Karasar, 2008: 86-87).

Study Group

The study was conducted with 37 students who were attending 2 different SACs in the west part of Turkey. The students were in the middle school 7th grade level. In the process of the determination of the study sample, purposive sampling method which is one of the non-probable and non-random sampling methods was used (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz and Demirel, 2010: 89). In this approach, information rich cases according to the purpose of the study are selected and investigated in depth (Büyüköztürk et al., 2010: 89). The present study focused on the students who were determined to be gifted and who attended SACs regarding the aim of the research.

Data Gathering Instrument

As data gathering instrument, a conceptual understanding test which involved 3 open ended questions developed by the researchers was utilized in the study. In order to supply the content validity of the instrument, views were asked from 2 chemistry education and 3 science education experts. As a result of those views, several improvements were made on the questions. The questions have been constructed upon cases which are encountered in our daily lives and involve chemical changes. It is aimed to find out how students explain those cases theoretically with the questions. The questions in data gathering instrument are phenomenologically framed questions which allow students apply their knowledge to a new situation as described by Driver and Erickson (1983) previously. Such questions were also utilized in a study conducted with high school and university level students on the subject of chemical kinetics (Cakmakcı, Leach and Donnelly, 2007) since the only reason of chemical education is not teaching abstract concepts but also the implementation of this knowledge into new situation and contexts.

In this study, the students' conceptual understandings are tried to find out by their explanations regarding the cases given in the questions in order to make the concepts concrete since the study group consists of relatively younger students. The questions in data gathering instrument and the concepts investigated via those questions are explained in Table 1:

Table 1: The Questions in Data Gathering Instrument and Related Concepts

No	Question	Related Concepts
1	The doctor gives Ayşe 2 different creams for the treatment of her acnes on her face. He tells Ayşe to apply one of the creams on day time while the other one during only night time by adding that otherwise it might cause spots on her face. How can you explain this situation?	In the first question, the concepts of "sun light" and "chemical change" are underlined.
2	The pharmacist explains Ali how to prepare the cough syrup by mixing it given by the doctor and asks Ali to keep the syrup in its black bottle with its cap closed. What might be the reason of the pharmacist for this request from Ali?	In the second question, the concepts of "precautions" which should be taken to avoid "chemical changes" that influence us negatively are highlighted.
3	Mine observes that the golden earrings, which she has been wearing for a year, keep its shining whereas the silver earrings have tarnished. How do you explain this case?	In the third question, the concepts of "the structure of matter" and "chemical change" are focused on.

In the responses of the students to the questions, it was analyzed in what level they reflected scientific arguments on their statements provided for the cases given to them. So, for each of those questions, respectively, it was investigated that.

- The cream which should be applied on face during night time might react with sunlight if it is applied during day time and go on chemical change.
- The cough syrup should be kept in its black bottle and cap closed in order to avoid its contact with sunlight and air, thus to take precaution for avoiding it going on chemical change and spoiling.
- The earrings are made up of different elements whose structures are different. Hence, their color change by time in another words tendency to go on chemical changes might be different.

In the present study, the subject of chemical changes has been addressed. This subject takes place in middle school 6th grade level science teaching program. The subject of matter takes place in both 6th and 7th grade level science teaching program according to the spiral structure of the program. The questions in data gathering instrument intends to determine the conceptual understandings of the 7th grade level students about different cases given to them with their present knowledge.

Data Analysis

The written responses to the questions given by the students were examined one by one by each of the researchers of the study. As a result of this examination, students' responses were taken into content analysis. Content analysis is an analysis procedure which intends to reach concepts and relationships that could explain collected data, define data and find out the facts in which collected data might be hiding (Yıldırım and Şimşek, 2008: 227).

In this study, previously traced analysis methods in the literature were utilized in the analysis of collected data. Kocakülah (1999) used the categories "scientifically acceptable arguments" and "scientifically unacceptable arguments" primarily in the analysis of the open ended questions which were obtained from his study related to the investigation of the development of university freshman students' understandings regarding the subject of electromagnetism. Then, he examined the category "scientifically acceptable arguments" under the categories "full argument" and "part of argument". Kocakülah (1999) indicated that the number of sub-categories related to "scientifically acceptable arguments" might change from question to question regarding the content of the question. The category – "scientifically unacceptable arguments" were analyzed under 2 sub-categories which were "related to the magnetic field and force" and "not related to the magnetic field and force". In the present study, however, as a result of the examinations, it was determined that the utilization of 4 major categories was appropriate for the analysis of collected data, namely – "scientifically acceptable

arguments", "scientifically unacceptable arguments", "not coded" and "no response". The data under the category "scientifically acceptable arguments" were analyzed under two sub categories "full argument" and "part of the argument". The explanations of those categories are as follows:

- Scientifically Acceptable Arguments:
  - Full Argument (FA): Responses which explain the concepts in the question in a fully scientific manner.
  - Part of Argument (PA): Responses which explain the concepts in the question in a partially scientific manner.
- Scientifically Unacceptable Arguments: The explanations which stay out of the scientific responses, they can be coded however they involve misconceptions, intuitive approaches.
- Not Coded: The responses which cannot be interpreted and are not related to the question. Also, reputational statements as the question are evaluated under this category.
- No Response: Those who did not provide any explanation.

The agreements and disagreements among the analyses of each researcher were compared and examined after the researchers made the analyses according to the same themes separately and individually. Quantitative comparison of the consistency between two researchers' coding similarities and differences is a method which is appealed in qualitative researches (Yıldırım and Şimşek, 2008: 233). In the present study, inter-consistency coefficient for data analyses of two researchers was calculated according to the formula stated below (Novak, 1977):

$p = (N_a \times 100) / N_t$

In this formula, N_a indicates the number of students who have been coded in the same way by both of the researchers; N_t indicates the total number of the students and p indicates the percentage of the consistency. The reliability of data analyses increases as p increases. Data analyses are reported to be reliable when the percentage of the consistency stays above 70% (Yıldırım and Şimşek, 2008: 233). Inter-consistency percentages for the analyses of each question and for the total of the analyses are shown in Table 2.

Table 2: Inter-Consistency Percentages for Data Analyses

Question No	p	P_{avr}
1	91.9	
2	89.2	89.2
3	86.5	

According to Table 2, it is seen that the inter-consistency percentages are above 80% in each data analyses and it is 89.2% for the total. Hence, it can be concluded that data analyses are reliable. Discussions were carried on between two researchers to arrive an agreement for the analyses in which researchers disagreed about. Thus, the distributions of the categories have been determined for data.

FINDINGS

The findings obtained from data collection instrument are presented under related categories with sample student responses to illustrate those categories in the form of tables.

The Findings Obtained from the First Question

The findings obtained from the question, "The doctor gives Ayşe 2 different creams for the treatment of her acnes on her face. He tells Ayşe to apply one of the creams on day time while the other one during only night time by adding that otherwise it might cause spots on her face. How can you explain this situation?" are shown in Table 3.

Table 3: The Analysis of the First Question

Categories	Scientifically Acceptable		Scientifically Unacceptable	Not Coded	No Response
	FA	PA			
f	19	9	-	4	5
Sample Response	Night cream is not applied on face during day time because several substances react with sun light. Night cream goes on reaction with sun light if it is applied on day time.	The structures of both dreams are different. The interaction of two creams with sun light is different.	-	The cream is imitation. I think the first cream treats while the second one decreases the side effects.	?

For this question, scientifically acceptable arguments were obtained from most of the students (n=28). No scientifically unacceptable arguments were obtained. The excess of scientifically acceptable arguments are full arguments (n= 19). Among the full argument responses, it was determined that the students could provide explanations by making connections between sun light and chemical reaction for the cream which needs not to be applied on face during night time. In part of arguments (n= 9), it was assessed that the students could make connection with only one of the concepts in their explanations. For example, if they mentioned sun light in their response, they failed to use the concept of chemical change clearly. For the category – not coded (n=4), it was defined that the students made various interpretations which are distant from scientific approaches. Five students did not respond to the question.

The Findings Obtained from the Second Question

The findings obtained from the question, "The pharmacist explains Ali how to prepare the cough syrup by mixing it given by the doctor and asks Ali to keep the syrup in its black bottle with its cap closed. What might be the reason of the pharmacist for this request from Ali?" are demonstrated in Table 4.

Table 4: The Analysis of the Second Question

Categories	Scientifically Acceptable		Scientifically Unacceptable	Not Coded	No Response
	FA	PA			
f	10	14	8	3	2
Sample Response	The sunlight may cause chemical reaction. If its cap is not closed, it can go on reaction with the air. To avoid the syrup going on reaction with sun light and air.	The medicine might lose its chemical property.	It is needed to close its cap and absorb light to keep it in room temperature.	To avoid seeing what is inside it. Because glass means health.	-

For the second question, usually scientifically acceptable arguments (n=24) were obtained from the students. However, among those responses, the amount of part of arguments (n=14) were found to be more than the full arguments (n=10) who explained that the medicine had to be kept in that way in order to avoid its contact with air and sun light and avoid its spoiling. Besides, the students who related that case with concepts other than chemical change were assessed under the category – scientifically unacceptable responses (n=8). The

interpretations other than scientific approaches were included under the category – not coded (n=3). Two students did not respond to the question.

The Findings Obtained from the Third Question

The findings obtained from the question, "Mine observes that the golden earrings, which she has been wearing for a year, keep its shining whereas the silver earrings have tarnished. How do you explain this case?" are demonstrated in Table 5.

Table 5: The Analysis of the Third Question

Categories	Scientifically Acceptable		Scientifically Unacceptable	Not Coded	No Response
	FA	PA			
f	10	7	16	2	2
Sample Response	Gold is not oxidized but silver is oxidized. Oxidation is a chemical process.	The structure of golden earring is not prone to decaying. The structure of silver cannot keep itself.	Silver is less resistive when compared to gold. Gold is more resistive.	Presumably, the rings are false.	I do not know.

About half of the students (n=17) responded to the third question in a scientifically acceptable way. Among those responses, the arguments, which indicated the fact that oxidation situation might differ since gold and silver were different matters, or their color change might differ due to that reason, were assessed under the category FA (n=10). The arguments which tried to highlight that gold and silver were different kinds of matter but did not make clear connection with the concept of chemical change were collected under the category – PA (n=7). Further, several responses such as "gold is more powerful", "gold is more resistive" were found out among the findings. The arguments which explained the case in the question with the concepts "powerful/powerless", "resisting/unresisting" were included under the category – scientifically unacceptable arguments (n=16). Among scientifically unacceptable arguments, one student was found to make an explanation in the following way: "*Silver becomes moldy due to the fact that it is ordinary*." Such an explanation indicates us that becoming moldy and rusty (oxidation) are two concepts which are confused by the students; in another words, it indicates a misconception. About half of the students were seen to provide scientifically unacceptable arguments. Similar to the previous findings, several not coded arguments (n=2) were obtained in addition to 2 students who did not answer the question.

DISCUSSION AND CONCLUSION

As a result of this study, it was determined that the proportion of scientifically acceptable arguments provided by the students for the cases given them is more than scientifically unacceptable arguments. This is a nice result which shows that the students, who have been determined to be gifted, connect daily life issues with science and make explanations in a scientific manner successfully. Thus, as indicated previously, one of the fundamental goals of science education, making students realize the place of scientific concepts in daily life (Çepni, 2011: 9) can be achieved.

When the questions in data gathering instrument are analyzed, it is clear that the proportion of scientifically acceptable arguments given by the students show a decrease as the provided cases move from general to more specific. This situation – general/specific cases in the questions can be explained as follows: In the first question, the contact of the medicine with sunlight is considered whereas in the second question, the contact with both sunlight and air in terms of taking precaution is considered. In the third question, on the other hand, the students' connection of chemical change with different structure matters by considering those matters as different elements is expected. This consequence demonstrates a parallelism with a previously conducted study finding in the literature (Doğan, 2007). In Doğan's study, SAC students, who attended the study, were determined to be more successful in the macroscopic properties of matter about vaporization, condensation

and boiling when compared to the properties which cannot be realized with naked eye or microscopic properties and daily life explanations which required making various connections. Those consequences point out the significance of questioning in education. It is necessary to make students ask questions and encourage class debates despite passing the subjects and concepts superficially. One characteristic of gifted students is the fact that they ask interesting questions about the subjects (Dağlıoğlu, 2014: 60). Surely, satisfactory explanations during such dialogs provided by the teachers to the questions of gifted students are beneficial in terms of increasing the learning curiosity of them. Thus, the opportunity of touching more detailed and specific points during instruction might be gained.

In order to be more beneficial for gifted students, workshops, seminars, in-service trainings can be provided for SAC teachers by the National Ministry of Education in the country wide. In those activities, what the teachers can make in order to raise the effectiveness of their instruction in SACs can be discussed. In addition, sample cases might be presented. Thus, SAC teachers can find an opportunity to share their ideas although there is no obligatory teaching program to be applied one to one. The teachers can be made aware of the innovations also in this way. So, the development of SAC teachers might be supplied.

The 7th grade level gifted participants of the present study have been attending their SACs for about 4 years. Due to this reason, those students have acquired the facility to observe various events, make experimentations and gain higher level knowledge and abilities. At this aspect, it is important to serve a qualified education opportunity for all SAC students. Accordingly, one reason of this education is the improvement of the levels of conceptual understandings of the students. For this reason, if we move from the results of the present study, the levels of conceptual understandings of the students should be considered during the design of teaching activities for these students. However, unfortunately, no sufficient study is present related to that field. There is a need for more studies to find out the conceptual understandings of the gifted students related to different concepts in addition to the present studies in the literature (Doğan, 2007; Vural, 2010). Thus, a more efficient education process can be conducted in SACs which own a significant role in the education of gifted children by improving students' conceptual understandings correctly about chemistry.

Similarly, conceptual understanding tests can be beneficial for educators during the processes of designing and preparing more qualified activities by finding out how students connect the scientific concepts with daily life issues. Conduction of the instruction relevantly is a situation which has been addressed in the literature (Holbrook, 2005; De Jong and Talanquer, 2015: 11). What is more, the activities which have been designed and prepared in this way contribute to the improvement of the students' conceptual understandings.

WJEIS's Note 1: This study is a part of Handan Ürek's phD dissertation.

WJEIS's Note 2: This article was presented at 4th World Conference on Educational and Instructional Studies-WCEIS, 05-07 November, 2015, Antalya-Turkey and was selected for publication for Volume 6 Number 1 of WJEIS 2016 by WJEIS Scientific Committee.

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