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Abstract. *Inquiry-based learning is a usable approach in developing gifted and talented students' learning and one that overlaps with their properties and learning needs. The aim of this research was to examine the effect of guided inquiry-based learning approach compared with that of traditional teacher-centered instruction on gifted and talented eighth grade students' understanding of acids-bases concepts and motivation towards science learning. A non-equivalent control group design was used in the research. The participants were 40 gifted and talented eighth grade students from one Science and Art Center in Ankara/Turkey. There were two different groups: the experimental group and the control group. The Acids and Bases Diagnostic Test and Students' Motivation towards Science Learning questionnaire were used in the research as data collection tools. Before and after the implementation, the tools were administered as pre-test and post-test to both groups. For data analysis the independent samples t-test and multivariate analysis of variance (MANOVA) was used. The results showed that there was a statistical significant difference between the groups in favor of the experimental group.*

Keywords: *guided inquiry-based learning, acids-bases concepts, gifted and talented students, achievement, motivation towards science learning.*

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THE EFFECT OF INQUIRY-BASED LEARNING ON GIFTED AND TALENTED STUDENTS' UNDERSTANDING OF ACIDS-BASES CONCEPTS AND MOTIVATION

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Introduction

As science arouses the curiosity of gifted and talented students regarding their natural environment and objects, such students take an interest in the subject (Smutny & von Fremd, 2004). Today's science education emphasizes learning, which enables students to learn by going through their own exploratory processes and by taking an active part in these processes (Chang, Sung, & Lee, 2003). The quality of science education is important in unveiling and developing the potential of gifted and talented students. Those who learn through high-quality science education have the opportunity to use basic skills in meaningful contexts and to form a life-long interest (Cronin, Patton, & Wood, 2007); to develop higher-order thinking and problem-solving skills (Carnine, 1992; Woodward & Noell, 1992) and to develop experimental experiences in constructing the knowledge with which they integrate new ideas, associations and details (Jenkins, Stein, & Osborn, 1981, cited in Pol-loway, Serna, Patton, & Bailey, 2013). Chiappetta (1997) said that a learning environment, in which students are curious and make an effort to learn, should be observed in a science classroom and pointed out that students should ask questions, resolve inconsistencies, form models, share their ideas, discuss their knowledge and solve problems in such an environment. The researcher also stresses that the "vision of science teaching" is associated with the term "inquiry." "Inquiry-based learning," enabling learners to structure their knowledge by including them in the nature of science (Roth, 1992), is based on the constructivist approach. In the constructivist approach, which is based on philosophy and psychology (Fosnot, 1992), the learners actively construct knowledge (Brooks & Brooks, 1999; Harris & Alexander 1998; Tynjälä, 1999). Previous studies have found that when learners actively participate in the learning process using this approach, they assume more responsibility for their learning, they learn permanently, and their ability to apply their knowledge to other fields also develops (Bodner, 1990; Hand & Treagust, 1991; Laverty & McGarvey, 1991).

The term "inquiry" has gained increasing importance in educational studies since it first appeared in the early 20th century, and it has become one of the approaches that researchers study (Anderson, 2002; Barron & Darling-Hammond, 2008; Barrow, 2006). Anderson (2002) states that in the



late 20th century good science teaching and learning became explicitly and increasingly associated with the term inquiry. Inquiry is described as an active process in which children actively investigate, by inquiring about their own world, asking questions and answering their own questions (McBride, Bhatti, Hannan, & Feinberg, 2004). Perry and Richardson (2001) define inquiry-based learning as learning the process of transforming data into useful knowledge by asking questions, researching and analyzing knowledge, whereas Barron and Darling-Hammond (2008) define it as one of the active learning approaches, which is student-centered and is based on asking questions, critical thinking and problem solving.

In recent years, inquiry-based science teaching has been considered as the main teaching method at primary and secondary school levels (Rocard et al., 2007). Inquiry-based learning has also led to changes in science teaching. The changes emerge with the active use of scientific process skills and critical thinking skills, instead of memorizing the concepts; hence, meaningful learning is achieved (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996). Accordingly, students form explanations through critical and logical thinking in the process of inquiry and in this way they develop their understanding of science (Harlen, 2004). Inquiry-based science teaching facilitates the understanding of basic principles, theories and concepts; instilling the ability to ask questions and to answer them; developing positive attitudes towards science and understanding the nature of science (Chiappetta & Adams, 2004). Inquiry-based learning is a usable approach in developing gifted and talented students' learning and one that overlaps with their properties and learning needs (Eysink, Gersen, & Gijlers, 2015; Trna, 2014; VanTassel-Baska & Brown, 2007).

Inquiry-based learning environments result in an increase in learners' interest and motivation in a course, in addition to helping them learn in depth and learn meaningfully and conceptually (Alvarado & Herr, 2003). Motivation, which is one of the most important elements in learning environments (Maehr, 1984; Freedman, 1997) and one of the most important factors influencing students' achievement (Karlsson, 1996), is defined as a process in which goal-oriented activities are encouraged and sustainability is assured (Pintrich & Schunk, 2002). It was found that factors, such as students' interest in a subject, their success or failure in developing a scientific understanding, their general goals and affective inclinations, curricula and social goals, influenced students' motivation (Hynd, Holschuh, & Nist, 2000; Lee & Brophy, 1996; Nolen & Haladyna, 1990). This is because, for students who learn science, motivation plays a central role in the process of their conceptual change, in their critical thinking, in learning strategies and in science achievement (Pintrich, Marx, & Boyle, 1993; Lee & Brophy, 1996; Wigfield & Wentzel, 2007; Wolters, 1999) and is a significant factor in their learning (Bonney, Kempler, Zusho, Coppola, & Pintrich, 2005). Therefore, in addition to factors influencing their cognitive process, factors that raise students' motivation should be included in learning environments (Anderman & Young, 1994; Lee & Brophy, 1996; Pintrich et al., 1993; Tuan, Chin, Tsai, & Cheng, 2005; Zusho, Pintrich, & Coppola, 2003).

Significance and Aim of the Research

On reviewing the literature, it was found that students had difficulty in understanding "acids and bases", an important subject in the field of science and chemistry, and they could not fully understand the subject and had misconceptions about it (Acar-Sesen & Tarhan, 2011; Bradley & Mosimege, 1998; Cartrette & Mayo, 2011; Çetingül & Geban, 2005; Demircioğlu, Ayas, & Demircioğlu, 2005; Furio-Mas, Calatayud, Guisasaola, & Furio-Gomez, 2005; Kousathana, Demerouti, & Tsaparlis, 2005; McClary & Talanquer 2011; Bretz & McClary, 2014; Nakhleh, 1994; Nakhleh & Krajcik, 1994; Özmen, Demircioğlu, & Coll, 2009; Pınarbaşı, 2007; Rahayu, Chandrasegaran, Treagust, Kita, & Ibnu, 2011; Ross & Munby 1991; Sheppard, 1997; Smith & Metz, 1996; Vidyapati & Seetharamappa, 1995). In Turkey, the subject of acids-bases is taught to students for the first time at grade 8 within the scope of a science course. Since students' prior knowledge and their misconceptions have an effect on their subsequent learning (Andersson, 1986; Griffiths & Preston, 1992; Saunders & Shepardson, 1987), it is important for them to have prior knowledge and understanding in acids-bases to understand the other subjects of chemistry.

The motivation of gifted and talented students, who differ from their peers in such properties as asking too many questions, curiosity and extraordinary ideas, using knowledge to support their ideas, inferencing and putting forward new ideas, creativity and desire to learn how things work (Trna, 2014), have a determining role in improving their giftedness (Mönks & Ypenburg, 2002, cited in, Trna, 2014). Classroom environments where students are responsible for their own learning, rather than classroom environments where there is active teaching, are important for gifted and talented students, who are supposed to have intrinsic motivation and high abilities to regulate their own learning process (Yoon, 2009). It has been pointed out that no other course domains can



influence and stimulate or force gifted and talented students as sciences do (VanTassel-Baska & Stambaugh, 2006). Such students should receive education in learning environments that are arranged in a way that directs them to the domain of sciences and learn meaningfully, according to their needs. VanTassel-Baska (2006) states that the unqualified and inadequate teaching of science at primary school level results in losing students who are interested in sciences. Therefore, the effective and differentiated learning environments that can be designed in this field will result in the improvement of gifted and talented students' curiosity, interest, knowledge, their desire to do research, their creative inference and problem solving skills, as well as increasing their motivation for science. Furthermore, designing learning environments for such students, implementing them and assessing the results will certainly guide educators working in this field. While only a restricted number of studies were found in the literature that involved inquiry-based learning activities conducted with gifted and talented students (Eysink et al., 2015; Reger, 2006; Trna, 2014; Wolfe, 1990; Yoon, 2009; Quade Denny, 2011), no studies were encountered in which activities for gifted and talented students were designed or applied in relation to acids-bases, and in which results were evaluated in guided inquiry learning environments. Therefore, the aim of this research was to examine the effect of guided inquiry-based learning approach compared with that of traditional teacher-centered instruction on gifted and talented eighth grade students' understanding of acids-bases concepts and motivation towards science learning. In this respect, the research questions are as follows:

1. Are there any statistically significant differences between students' Acids and Bases Diagnostic Test post-test scores according to the teaching methods?
2. Are there any statistically significant differences between students' motivation towards science learning (self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, learning environment stimulation) according to the teaching methods?

Methodology of Research

Research Design

In this research, the "Nonequivalent control group pretest-posttest design" was used, in which two treatment groups are pretested, administered a treatment and post-tested (Gay & Airasian, 2000). As summarized in Table 1, one group was randomly assigned to the experimental group, where 20 students (15 males and 5 females) were taught using the guided inquiry-based learning approach; the other group was randomly assigned to the control group, where 20 students (14 males and 6 females) were instructed using the traditional approach.

Students in both groups were administered the Acids and Bases Diagnostic Test (ABDT) and the Students' Motivation towards Science Learning (SMTSL) questionnaire as pre-test and post-test.

Table 1. Nonequivalent control group design.

Groups	Treatment	
	Pre-test	Post-test
Experimental Group	<ul style="list-style-type: none"> • ABDT • SMTSL 	Guided inquiry based learning approach <ul style="list-style-type: none"> • ABDT • SMTSL
Control Group	<ul style="list-style-type: none"> • ABDT • SMTSL 	Traditional teacher- centered instruction <ul style="list-style-type: none"> • ABDT • SMTSL

Participants

This research was conducted with 40 gifted and talented eighth grade students (29 male and 11 female) attending the Science and Art Centre in Ankara. The participants were approximately 13-14 years old. In 2016 there were 83 Science and Art Centers in 69 provinces for gifted and talented children in Turkey (Ministry of National Education [MNE], 2015-2016 Science and Art Centers Students Identification Guide), and primary and secondary school students, who have been identified as gifted and talented, go to these centers after school hours and at



weekends (MNE, 2007). The MNE- Guide for Science and Art Centers (2007) defines Science and Art Centers as independent private institutions of education that have been opened to ensure that gifted and talented children/students of pre-school, primary and secondary school age can become aware of their individual capabilities and use their capabilities to the maximum, by improving them.

Instruments

Acids and bases diagnostic test (ABDT): A two-tier diagnostic test was developed by the researcher to determine the students' levels of understanding on the subject of acids-bases and development in their levels of knowledge. In the first tier of the test, the students were asked to choose the correct alternative. In the second tier, they were asked to choose the correct reason for their choice in the first tier and if there was not a choice to explain their reason, they were asked to write their reason in the blank space provided for the last alternative. The test was evaluated by assigning "1" point to correct answers to both tiers of the test and "0" point to incorrect answers to both tiers or to one tier. The maximum achievable score from the test was 20 and the minimum score was 0. The test covers the topics of the properties of acids and bases, the names and formulas of acids and bases, acid-base reactions, the measurement of acidity and basicity and acids and bases in daily life. While preparing the test, the literature was reviewed and the statements concerning "acids and bases" about which students had misconceptions (Bradley & Mosimege, 1998; Canpolat, Pınarbaşı, Bayrakçeken, & Geban, 2004; Cros et al., 1986; Çetingül & Geban, 2005; Demirci & Özmen, 2012; Demircioğlu et al., 2005; Köseoğlu, Budak, & Kavak, 2002; Morgil, Yılmaz, Şen, & Yavuz, 2002; Nakhleh & Krajcik, 1994; Özmen et al., 2009; Ross & Munby, 1991; Sheppard, 2006; Smith & Metz, 1996; Tarhan & Acar-Sesen, 2012; Yahşi, 2006), were included in the test as distractors. Thus, a 20-item test at the level of the students was prepared. In order to provide construct validity, learning outcomes and misconceptions related to subject of acids-bases were determined and also the tables of specification were prepared, using the science textbooks (Ünver, 2014; Erbaş, 2015) that were being used in Turkey. To attain content and face validity, experts from Chemistry Education and Science Education analyzed the developed test. The Cronbach's alpha reliability coefficient for the test was found to be 0.831.

Sample questions:

1) Which of the following is not a property of acids?

- A) They feel slippery on the skin.
- B) They taste sour.
- C) They turn blue litmus paper into red.

The reason for the answer above:

- A) Causing the feeling of slipperiness on contacting the skin is of the properties of bases.
- B) Acids taste bitter but bases taste sour.
- C) Turning blue litmus paper into red is a property of bases. Acids turn red litmus paper into blue.
- D) I think,

2) Which of the following materials can be used to remove the limescale layer in the teapots?

- A) Vinegar
- B) Soapy water

The reason for the answer above:

- A) The limescale is acidic, soap is basic. The result of neutralization reactions between the limescale layer and the soap, the limescale layers are removed.
- B) The limescale is basic and vinegar is acidic. The result of neutralization reactions between the limescale layer and vinegar, the limescale layers are removed.
- C) The limescale and soapy water are basic. A base can only lose its effect with a base.
- D) I think,

Students' Motivation towards Science Learning (SMTSL) Questionnaire: "Students' Motivation Towards Science Learning" questionnaire, developed by Tuan, Chin and Shieh (2005) and adapted into Turkish by Yılmaz and Huyugüzel-Çavaş (2007), was used to determine the students' motivation for science learning. The questionnaire consists of 33 items with a five-point Likert-type scale (1= strongly disagree; 5= strongly agree) and 6 factors, which are "self-efficacy (7-item), active learning strategies (7-item), science learning value (5-item), performance goal



(3-item), achievement goal (5-item), learning environment stimulation (6-item).” The Cronbach’s alpha reliability coefficients were calculated for the overall scale as 0.87; the self-efficacy factor as 0.71; the active learning strategies factor as 0.85; the science learning value factor as 0.74; the performance goal factor as 0.54; the achievement goal factor as 0.77 and the learning environment stimulation factor as 0.77 (Yılmaz & Huyugüzel-Çavaş, 2007).

Procedure

The guided inquiry learning approach was used in experimental group and traditional teaching method was used in control group. Six weeks of teaching were designed for each group. The instructional activities were developed by the researchers and reviewed by two experts from science education and chemistry education to examine the compliance of activities in terms of content and students’-level. Activities prepared in this research are based on the topics and concepts shown in Table 2.

Table 2. Topics and concepts/terms under the title of acids-bases while designing the application process.

Topics	Concepts/ Terms
<ul style="list-style-type: none"> • The Properties of Acids and Bases • The Names and formulas of Acids and Bases • Acid-Base Reactions • The measurement of Acidity and basicity • Acids and Bases in Daily Life • Acid Rains 	<ul style="list-style-type: none"> • Acid • Base • Salt • Neutralization • Titration • Indicator • pH • pOH • Weak acid/ Weak base • Strong acid / Strong base

The participants had not previously learned the subject of acids-bases. The same teacher conducted the applications in the experimental and control groups. Two groups were observed for controlling teacher effect, and treatment verification. The ABDT and SMTSL questionnaires were given to the students as a pre-test, two weeks before teaching the subject of acids-bases and as a post-test, one week after the application.

Application Process in the Experimental Group

The subject of acids-bases was taught through guided inquiry activities in the experimental group. The following activities were prepared for the topics:

- Which concepts is it related to?
- I wonder, and I explore...
- Is there a measure for acidity and basicity?
- Where did the acid and base go?
- I could not decide on whether it is useful or harmful...
- Is there acid rain?

Guided inquiry, one of inquiry-based learning levels, is the level of inquiry at which the teacher introduces a problem. The choice of methods used for solution is left to the students; the students are given the opportunity to discover, research, create knowledge and learn meaningfully and thus they are motivated (Llewellyn, 2007; Spaulding, 2001). The teacher leads the students at this stage with questions and gives them guidance (Lim, 2001).

The inquiry cycle (Figure 1), which was designed by Llewellyn (2007, 2014) as a guide in planning the inquiry-based learning environments, was used in performing the guided inquiry activities.



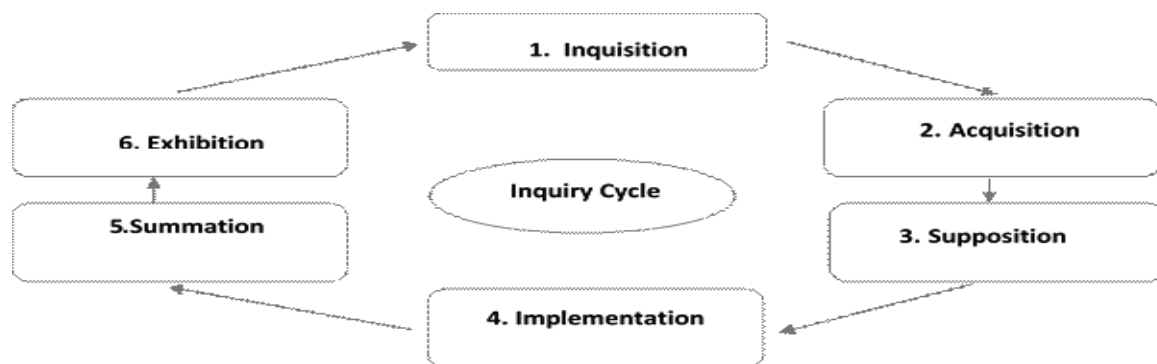


Figure 1: Inquiry cycle (Llewellyn, 2007, 2014).

The stages of the inquiry cycle taken by the students during the activities (Llewellyn, 2007, 2014) and the roles they and the teacher adopted while going through the stages were as in the following:

A Sample Activity: "Is there a measure for acidity and basicity?"

The aim of this activity is to make sure that students are able to comprehend the concepts of pH and pOH, which are the measures of acidity and basicity and the relations between them, that they can read the pH scale and that they become aware of the approximate pH values of the materials they encounter in daily life. The pictures of various materials used in daily life, together with their pH values, are shown on the activity paper.

Diluted NaOH solution, HCl solution, NH_3 solution and laundry bleach, liquid soap, anti-limescale, vinegar, orange juice, bottled water of various brands in beakers and pH paper and litmus paper were prepared in the laboratory for each group. While working the students used aprons, gloves and goggles. As the students conducted each activity in groups, they were divided into groups of four prior to the applications.

1. Inquisition: The first stage of the Inquiry Cycle; the students begin the process of inquiry. It is important for students taking part in inquiry cycle activities for the first time to be guided by the teacher. The students study the activity paper given to them and ask questions (for example, Is there a measure for acidity? Is there a measure of basicity? etc.). The teacher's role is to be a listener, he does not give direct answers to the students' questions, but encourages and guides the students to ask questions by offering explanatory and probing questions. The students discuss the answers in groups and write them down.

2. Acquisition: The second stage of the Inquiry Cycle; the students ask themselves the question "what knowledge do I have in order to answer this question?" and share their prior knowledge to enable them to answer the questions. They brainstorm with guidance from their teacher and have in-group and inter-group discussions. In this process they can ask the teacher questions about things they do not know but the teacher helps the students to reach the answer by leading them, instead of directly giving the answers.

3. Supposition: During the third stage of the Inquiry Cycle; students make guesses and hypothesize, in order to find answers to the research questions.

The students make guesses (set up hypotheses) such as, "I think the materials we use in daily life are of a basic character" or "I think the pH value is used only for acidity measure" by using their knowledge gained from the previous stage, so as to find answers to the research questions.

4. Implementation: The fourth stage of the Inquiry Cycle, involves the students' planning and the implementation of their plans to answer the research questions. While the students investigate the answers to their questions, they review resources (books or the internet) if there is a lack of knowledge. The teacher can make brief explanations to advise the students during their research.

The students plan the type of research they are going to carry out (searching for resources, making experiments, observations, etc.) to test their hypotheses, in the light of the information they obtained. Then they implement their plan (e.g. they determine the pH values of the materials with pH paper...). When an experiment for concentrated acids or bases has been designed, the teacher can conduct it in the fume cupboard.

5. Summation: During the fifth stage of the Inquiry Cycle; the students record their experiments, their conclu-



sions and observations for their research questions and hypotheses. Then they interpret them by analyzing them, such as: it is acidic when the pH value is between 0 and 7, neutral when it is 7, basic when it is between 7 and 14.

6. *Exhibition*: During the sixth stage of the Inquiry Cycle; the students share the results they have obtained and the new knowledge they have acquired with their peers and their teacher.

A group spokesman orally shares the knowledge from each application, such as: "the measure of acidity and basicity that we asked about at the beginning is explained with the concepts of pH and pOH. Both concepts tell us about acidity and basicity. We have reviewed resources and made experiments to reach this understanding..."

In conclusion, the students acquire knowledge about pH and pOH concepts by using the cycle of inquiry. The teacher makes a summary by asking questions so that lacking or mistaken parts can be re-arranged after sharing the results.

Application Process in the Control Group

When teaching the subject of acids-bases to the control group, the traditional teaching method, in which the teacher is active, was used. In this method, the teacher taught the subject of acids-bases to the students by instruction at the board, by giving examples and by supporting the teaching with visuals from the internet when necessary. In addition to this, the teacher asked students questions and led the students to in-class discussions. For instance, during the activity, "Is there a measure for acidity and basicity", students in control group made only confirmatory experiments without questioning, inquiry, awareness of their prior knowledge, group discussions, hypotheses, planning and implementing their plans to answer the questions, interpreting their conclusions by analyzing their observation and sharing their results. The teacher then explained the results that were obtained, and answered the students' questions. At the end of the class, the teacher summarized the purpose of the lesson.

Data Analysis

Having checked whether or not the assumptions of normality, equality of variance, equality of covariance matrices and independency of observation were met, analyses were performed. Prior to the applications in the experimental and the control groups, Multivariate analysis of variance (MANOVA) and independent sample t-test analyses were made, in order to find whether or not there were any differences between the scores for the dependent variables (six factors score and total score of SMTSL questionnaire, ABDT score). The MANOVA analysis was made to find whether or not there were any statistically significant differences between the experimental group and the control group students' six factors scores of the SMTSL questionnaire (self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, learning environment stimulation), whereas an independent samples t-test was made in order to find whether there were any statistically significant differences between the SMTSL total scores and the ABDT post-test scores.

Results of Research

Prior to the applications in the experimental and the control groups, the analysis results on whether or not there was any difference between the scores for the dependent variables are presented below. It was found that there were no statistically significant differences between the students' ABDT pre-test scores, which may be considered as an indicator of the students' prior knowledge of acids-bases ($t(38) = 0.917, p > .05$ ($p = .365$)). The MANOVA results suggest that there were no statistically significant differences between the experimental and control group students' pre-test scores in self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation factors of motivation, Wilks Lambda (Λ) = .760, $F(26,33) = 1.740, p > .01$ ($p = .143$)). There were no statistically significant differences between the students' SMTSL questionnaire total pre-test scores either, $t(38) = .648, p > .01$ ($p = .521$)).

In relation to the first research question, the effects of guided inquiry learning activities on the gifted and talented students' understanding the subject of acids-bases was found through the ABDT. According to Table 3, the mean scores of the ABDT post-test were calculated as $\bar{x} = 17.65$ for the experimental group students, and as $\bar{x} = 14.05$ for the control group students. Independent samples t-test results show that there were significant differences between the ABDT post-test scores, according to the teaching methods, $t = 6.315, p < .05$. Following the analyses, the value for eta-square (the size of effect, η^2) was calculated as $\eta^2 = 0.51$. The value shows how much of



the variance in the dependent variable is explained by the independent variable and accordingly, the values in the .01-.06 range mean small, .06 means medium, and .14 and above mean large (Cohen, 1988, cited in Akbulut, 2010). Thus, the size of the effect is quite large.

Table 3. Independent sample t- test results of students for ABDT- post-test scores.

Group	N	\bar{X}	SD	df	t	p	Levene's Test	
							F	p
Experimental	20	17.65	1.4964	38	6.315	.0001	.519	.447
Control	20	14.05	2.0641					

With regard to the second research question, the MANOVA indicated that there were significant differences between the gifted and talented students' post-test scores for self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation according to whether they learned through guided inquiry or the traditional method, Wilks Lambda (Λ)= .408, $F(6, 33)= 7.976$, $p < .01$.

Pallant (2010) said that a more reliable measure of alpha level should be determined while examining variance analysis tables, and suggested that the standard alpha level should be divided by the number of analyses made and the tables should be examined according to the alpha value found. In this research, the alpha value was found to be .008 on dividing the normal alpha level by the number of tests given (.05/6). An examination of Table 4, according to this new alpha value, demonstrates that there are significant differences between the experimental group and the control group students' post-test scores for self-efficacy, science learning value, performance goal and learning environment stimulation ($p < .008$). It could be said that by using partial eta-square values, 30.4% of self-efficacy post test scores, 22.8% of science learning value post test scores, 38.4% of performance goal post test scores and 29.4% of learning environment stimulation post test scores are explained by the variable of the teaching methods.

Table 4. Tests of between subject effects.

Source	Dependent Variable (post- test)	Type III Sum of Squares	df	Mean Square	F	p	Partial Eta-Squared
Group	Self-efficacy	156.025	1	156.025	16.564	.0001	.304
	Active learning strategies	21.025	1	21.025	1.483	.231	.038
	Science learning value	65.025	1	65.025	11.244	.002	.228
	Performance goal	108.900	1	108.900	23.687	.0001	.384
	Achievement goal	1.225	1	1.225	.092	.763	.002
	Learning environment stimulation	144.400	1	144.400	15.809	.0001	.294

Also, the sources for the significant difference between groups can be examined in the table of Estimated Marginal Means (Table 5).

Table 5. Estimated marginal means.

Dependent variable	Group	Mean	Std. Error	%95 Confidence Interval	
				Lower Bound	Upper Bound
Self-efficacy	Experimental	33.450	.686	32.061	34.839
	Control	29.500	.686	28.111	30.889



Dependent variable	Group	Mean	Std. Error	%95 Confidence Interval	
				Lower Bound	Upper Bound
Active learning strategies	Experimental	31.300	.842	29.596	33.004
	Control	29.850	.842	28.146	31.554
Science learning value	Experimental	23.200	.538	22.111	24.289
	Control	20.650	.686	19.561	21.739
Performance goal	Experimental	13.550	.479	12.579	14.521
	Control	10.250	.479	9.279	11.221
Achievement goal	Experimental	20.900	.815	19.250	22.550
	Control	20.550	.815	18.900	22.200
Learning environment stimulation	Experimental	26.650	.676	25.282	28.018
	Control	22.850	.676	21.482	24.218

According to Table 5, the significant difference between the experimental group and the control group students' post-test scores for self-efficacy, science learning value, performance goal and learning environment stimulation shown in Table 4 is in favor of the experimental group students.

The results for the independent samples t-test, which was performed so as to find whether or not there were any statistically significant differences between the experimental group and the control group students' SMTSL questionnaire post-test total scores, are shown in Table 6.

Table 6. Independent sample t- test results of students for SMTSL questionnaire post-test total scores.

Group	N	\bar{X}	SD	df	t	p	Levene's Test	
							F	p
Experimental	20	149.05	11.104	38	3.965	.0001	.564	.457
Control	20	133.65	13.358					

According to Table 6, the students' SMTSL post-test total scores differ significantly between the experimental and the control group students (according to teaching methods), $t(38) = 3.965$, $p < .01$. Thus, the experimental group students' scores ($\bar{X} = 149.05$) are higher than those of the control group students' scores ($\bar{X} = 133.65$). This finding can be interpreted to show a significant correlation between the SMTSL questionnaire total scores and the method of teaching. Following the analyses, the effect size was calculated as $\eta^2 = 0.29$. Thus, the size of the effect is quite large.

Discussion

It was found that the level of achievement attained by the students in the experimental group, where the guided inquiry learning approach was used, was significantly higher than those in the control group, where the traditional learning method was employed. Inquiry-based learning is considered to be an approach that may be used in the improvement of gifted and talented students' learning and one that overlaps with their characteristics and learning needs (Eysink et al., 2015; Trna, 2014; VanTassel-Baska & Brown, 2007). It was also stated by MNE (2014) that evidence-based teaching strategies, such as critical thinking, creative thinking, problem solving and inquiry-based research, should be used with gifted and talented students so that certain gains could be obtained.

In a review of the literature, the availability of studies in which the inquiry-based learning approach is used, supports our findings. The researchers in these studies found that the approach is effective in students' learning and the approach results also increase in concept learning and students' achievement (Alvarado & Herr 2003; Brady-Orcutt, 1997; Chang & Mao, 1999; Gibson & Chase, 2002; Koksál & Berberoglu, 2014; Kowalczyk, 2003; Lawson, 2010;



Lord & Orkwiszewski, 2006; Mao & Chang, 1998; Shymansky, Hedges, & Woodworth, 1990; Tretter & Jones, 2003; Yager & Akcay, 2010). Harlen (2004), states that students think critically and logically in the inquiry process, and that they improve their understanding of science in this way. With the use of inquiry-based learning, students' abilities to make comments and to apply their learning into other fields develop, and they learn permanently and deeply by playing active roles in the process (Bodner, 1990; Colburn, 2004; Hand & Treagust, 1991; Laverty & McGarvey, 1991; Leonard 2000; Mullen, Rutledge, & Swain, 2003). Having analyzed 138 studies conducted between 1984 and 2000, Minner, Levy and Century (2010) synthesized the studies and found that with the application of inquiry-based science learning at various levels 51% of the studies had a positive effect on students' content learning and on assuring permanent learning. It was found in the studies that inquiry-based learning had more positive effects on students' achievement than traditional teaching (Basaža, Geban, & Tekkaya, 1994; Khan, Hussain, Ali, Majoka, & Ramzan, 2011; Koksai & Berberoglu, 2014; Richarson & Renner, 1970). Koksai and Berberoglu (2014) found that guided inquiry learning led to an increase in both the students' understanding of science concepts and their inquiry skills, in contrast to the traditional learning approach.

Likewise, the results obtained in this research also demonstrate that the guided inquiry learning approach is influential in the increase in gifted and talented students' motivation for science learning. Previous studies concluded that gifted and talented students' low motivation was among the problems encountered during teaching (Sak, 2010; Siegle & McCoach, 2005). Gifted and talented students' motivation influences their achievement (Phillips & Lindsay, 2006) and plays a determining role in improving their giftedness (Mönks & Ypenburg, 2002, cited in Trna, 2014). Learning and teaching approaches have a significant effect on the increase of such students' motivation (Phillips & Lindsay, 2006). Trna (2014) recommends inquiry-based learning in science education as a suitable approach for increasing gifted and talented students' motivation and assuring their improvement and points out that inquiry-based science learning is an appropriate approach for all students, including those who are gifted and talented. Strong influences in the motivation of learners are the primary reason for arguing in favor of inquiry-based learning (Spronken-Smith, 2007). Learners are more stimulated to learn during the inquiry process, in accordance with their curiosity, and are therefore more motivated (Ciardiello, 2003). Inquiry-based learning, which is based on the constructivist approach, motivates students with the hands-on activities it contains (Minner et al., 2010). Studies have also demonstrated that constructivist learning environments and learner-centered activities, rather than traditional methods (Ames, 1992; Bednar, Coughlin, Evans, & Sievers, 2002; Cluck & Hess, 2003; Kim, 2005; Pintrich et al., 1993; Pintrich & Schunk, 2002) are influential in increasing students' motivation.

It was found that there were significant differences in the four factors of the SMTSL questionnaire. The first factor of the SMTSL questionnaire is self-efficacy, which represents the gifted and talented students' beliefs in their individual efficacy; the second factor of the SMTSL questionnaire is science learning value, which enables students to gain the problem solving skills, to have inquiry based experiences, to think on their own and to find the appropriacy of science to their daily life; the third factor of the SMTSL questionnaire is the performance goal, which represents students' goals in learning science, as competition with other students and as attracting the teacher's interest and the last factor of the SMTSL questionnaire is learning environment stimulation, which contains factors such as the curriculum, teaching methods and interactions between students affecting students' motivation in learning environments. In studies concerning students' motivation for learning in science education, it was found that factors such as students' interest in a subject, their success or failure in developing a scientific conception, their general goals and affective orientations, curriculum and social objectives, all affected their motivation (Hynd et al., 2000; Lee & Brophy, 1996; Nolen & Haladyna, 1990). In the literature it was emphasized that students displayed success and put more effort into in-class activities if they had high motivation and positive attitudes (Green, Nelson, Martin, & Marsh, 2006; Pintrich & Schunk, 2002; Wolters & Rosenthal, 2000). Pintrich and Schunk (2002) refer to teachers' teaching strategies, teacher-student and student-student interactions, which are the elements of the learning environment, as elements influencing motivation for learning the in-class activities. When students find learning tasks valuable and meaningful, they are eager to actively participate in learning tasks (Tuan, Chin, & Shieh, 2005). It was found that inquiry-based learning applications were influential on the increasing in students' interest in a course and that students found the classes enjoyable and instructive (Ronning, 1998; Gibson & Chase, 2002; Keefer, 2002; Kyle, Bonnstetter, McCloskey, & Fults, 1985; Tatar & Kuru, 2009). Kyle et al. (1985) state that 75% of the students who were exposed to the inquiry-based learning approach found science enjoyable and exciting, whereas 50% of the students who were not exposed to this approach found science boring. They also state that students who participated in inquiry-based learning environments had positive perspectives with regard to science and scientists. Gibson and Chase (2002), on the other hand, state that 70% of the students attending an inquiry-based



science camp were pleased with the activities made in the camp and that learning through inquiry is influential in increasing the students' interest in science and in developing positive attitudes towards learning.

Conclusions

This research examined the effect of guided inquiry-based learning approach compared with that of traditional teaching method on gifted and talented eighth grade students' understanding of acids-bases concepts and motivation towards science learning. The results show that the guided inquiry learning activities which designed and applied in this research in relation to acids-bases were effective in the gifted and talented students' understanding the subject of acids-bases and influential in the increase in these students' motivation for science learning. In this context, it is recommended that inquiry-based learning environments for gifted and talented students are designed for different subjects in which students have difficulty and the effects of those environments on such students' understanding, motivation and attitudes are analyzed. Considering that there are only a limited number of studies investigating gifted and talented students' learning processes and the teaching models for such students, the results of this research may be considered as providing guidance for educators who work in this field.

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