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An Examination of the Sixth Graders' Learning Styles and Conceptual Understanding of Integers

Bahar Dinçer

Abstract

In the present study, it was evaluated whether the learning styles of the students had an effect on their level of conceptual understanding of integers in mathematics and their views regarding the use of analogy. In the current "single-group pre- and post-test" design, the study group consisted of 52 sixth grade students. The learning style inventory, conceptual understanding test, and visual analogy supported mathematics teaching evaluation form were applied to the students. For quantitative data, the nonparametric Wilcoxon Signed Ranks Test, Kruskal Kruskal-Wallis H test and Mann Whitney U test analyses conducted while the qualitative data were evaluated using the content analysis technique. Statistically significant increase in students' conceptual understanding of integers was found when pre- and post-test scores compared. The post-test scores of visual students were statistically significantly higher than those of both the auditory and tactile/kinesthetic students. Another finding of the study indicated that the students expressed a positive opinion on visual analogy-supported mathematics teaching approach; however, there was no statistically significant difference in student' perspectives among their learning styles.

Keywords: Learning style, analogy in teaching mathematics, use of analogy

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Introduction

In teaching mathematics, providing education in accordance with the students' developmental levels is considered as highly significant. For this reason, it is vital to enhance conceptual development in a way that will facilitate the learning of the target audience (Baykul, 2005). In order for mathematics educators to make progress in these areas, the process by which students develop mathematical conceptions must be better understood.

In the process of reaching the target audience, learner-centered education has gained substantial importance. Considering individual differences is the basis of learner-centered education. Each student has a different learning style which significantly

İzmir Democracy University, Department of Mathematics and Science Education, bahar.dincer@idu.edu.tr, ORCID: 0000-0003-4767-7791

affects their learning performance. The concept of learning styles was first introduced by German researchers in the 1900s as a result of the interest in individual differences (Curry, 1983).

Related studies show that there are many different models related to learning styles. Hall and Moseley (2005) in a review study on learning styles between 1902 and 2002 found 71 different learning style models. It is argued that each researcher makes his own definition for three main reasons. The first reason is that each researcher is concerned with one of the dimensions of the learning process; the second reason is that they use different measurement tools, and the third reason is that there are very different theoretical foundations for learning styles (Cano et al., 2000). Therefore, many definitions have been made for the concept of learning styles. Some of these definitions are presented as follows: Learning style is related to the individual's preferences in acquiring behavioral changes (Ferrer, 1990). Learning style is the way an individual focus, process and remember a new and difficult information (Dunn & Dunn, 1992). Learning styles define individual differences in the learning process resulting from the individual's learning preferences (Kolb & Kolb, 2005). Davidson (1990) and DeBello (1990) defined learning styles as the way an individual acquires, processes and stores information. James and Gardner (1995) expressed learning styles as a complex behavior style and the conditions in which learners most efficiently and effectively perceive, process, store and remember what they aim to learn.

Based on the present state of knowledge, it can be said that knowing the learning styles of students will make it easier to determine appropriate strategies, methods and techniques for the instructional design and teaching environment. In addition, it can be predicted that designing an education program related to learning styles will contribute to the academic success of learners and will also help learners develop positive motivation and attitude towards learning.

Another concept closely related to learning styles is learning environment. Piaget (1952) states that in order to enable students to understand mathematical concepts, learning environments with different experiences are needed. These learning environments offer different learning styles. It also paves the way for the possibility of learners' benefiting from different methods, which in turn would contribute to the development of the learning process. One of these methods is the use of analogy. Analogies have been used since early history to teach concepts to children and adults. In addition to their function of comparing an object or situation with another situation, analogies offer rich, concrete mental contents that transfer an unfamiliar knowledge/situation to a familiar field (Harrison & Treagust, 1993). There are five features that characterize the use of analogies in teaching processes (Else et al., 2003). These are:

Table 1

The Features of Analogies in Teaching Processes

Near vs. far	Analogies with more similarities with the object are "near", and analogies with less similarity are "far".
Simple vs. complex	Comparisons in which only one or two items map to target are simple analogies, whereas analogies with more detailed relationships are complex analogies.
Familiar vs. unfamiliar	Analogies may differ depending on the familiarity of students.
Visual vs. functional	Functional analogies are used to express what the intended concept is, and visual analogies are used to state what it is like. Some analogies serve both purposes.
Position	Analogies can be presented at the beginning of a new topic or after other types of experiences.

Based on the definition and characteristics of the concept of analogy, it can be stated that they have a facilitating effect on learning processes by presenting familiar and concrete contents to students One of the issues that students have difficulty within the process of concretization in mathematics is the concept of integers and operations with integers (Hayes & Stacey, 1990). According to Linchevski and Williams (1999), expanding the concept of number is difficult for students who are new to this subject. While the natural number structure that previously existed in the minds of students is a facilitator in learning positive numbers, this process is difficult in the cases that involve negative numbers (Mc Corkle, 2001). Since the sub-learning domain of integers includes many abstract concepts, it is considered beneficial to teach this subject with possible events in daily life and support it by near, simple, familiar and visual analogies. With this view, in the planning phase of the teaching activity, it is of great importance to determine how the learning environment needs to be organized to help students achieve the expected goals and acquire the desired behaviors. It is suggested that the planning of a learning environment supported by visual materials will make teaching more effective and relevant. The use of different support tools as in the education process is also important in terms of providing permanent learning change. The more a designed teaching activity appeals to different sensory organs, the more effective and permanent the learning will be. Therefore, arranging stimuli in the learning environment to address more than one sensory organ is a priority in terms of multiple learning environments in order to create a lasting learning experience (Seferoğlu, 2006). For this reason, the analogies within the scope of the study are not only expressed verbally, but also transferred to the digital format by supporting them with visual elements so that they appeal to more senses.

It is necessary to examine effective learning not only in terms of learning environment but also in relation to individual differences. The literature on this subject offers many frameworks. There are many authors who classify learning styles regarding individuals' perception preferences. The Barsch learning style model of which the present study was based on classifies learners according to how they take and internalize the information. Researchers based on the idea that individuals perceive all kinds of information with their sense organs categorize the learning styles as visual, auditory, tactile and kinesthetic, and they listed the characteristics of individuals according to their learning styles as follows. Visual learners work neatly and are disturbed by clutter, determine places for their belongings and try to keep them always in the same place. When visual materials are used, they learn more easily and remember what they learn by visualizing them. Visual learners are very good at speed reading, and they are sensitive to spelling, punctuation and other grammar rules in texts. Also, they use repetitions in their writing, which helps them with their learning process (Klavas, 1994). Auditory learners learn and remember more easily when they hear or listen. It is stated that these individuals start speaking quite early. They are sensitive to sound and music. In other words, they have improved speaking and listening skills. They prefer to learn by talking and discussing the subject. Group work is deemed appropriate as it provides the opportunity to speak and listen for these individuals. Since reading by eyes is not enough for them, they at least prefer to read in an audible voice. Due to the fact that they learn and remember easier through hearing rather than seeing, the narrative method is considered appropriate for auditory learners. It is also stated that auditory students are quite successful in learning foreign languages and in speaking local dialects (Barsch, 1996).

Many authors consider the kinesthetic and tactile learning styles together and state that these two learning styles cannot be separated from each other with clear lines as it is the case in visual and auditory features. Kinesthetic learners tend to move constantly, take on tasks such as cleaning the board in the classroom, closing the door, bringing chalk, opening the window. If they sit still for a long time, they move away from learning and show unwanted behaviors in the classroom. Therefore, these students can be unfairly described as naughty and lazy. Kinesthetic students cannot sufficiently benefit from visual and auditory tools in the learning environment. What they need is techniques that enable learning by doing and living. They learn more easily in the schoolyard, in laboratories or during excursions. Tactile students have also similar characteristics. They need to touch and feel objects related to learning material with their hands. The point where tactile students differ from kinesthetic students is that they learn more easily by using their hands and touching (Barsch, 1996).

The literature of learning style abounds with many studies that involve different learning style models prepared for different lessons. Özkan, Sungur, and Tekkaya (2004), for example, examined the effect of learning styles on students' success and found that there were significant differences in the biology achievements of students with different learning styles. In a study on secondary school students' learning styles and their success in social studies courses, it has been found that students' learning styles significantly affect their success in social studies courses (Bengiç, 2008). Dunn et al. (1990) investigated the effect of learning styles on student success and attitudes. Students were grouped based on their choice to learn alone, with their peers or with no preferences. The results of the analysis showed that the preference for learning alone occurs mostly in the conditions of learning alone, and the preference for peer learning takes place more when it is possible for individuals to learn from each other. Students who do not have a choice of learning style did better in situations where learning conditions would allow them to work on their own rather than with peers. In addition, students with a cooperative learning style preference showed more positive attitudes than those who did not prefer a certain learning style. Matthews (1996) emphasized the relationship between high school students' learning styles and their academic achievement. Collinson (2000) found that there is a significant difference between students' academic success depending on their learning style preferences. Çakır et al. (2002) examined the effects of case-based learning, learning styles and gender on students' performance and high-level learning abilities, attitudes towards biology lesson and academic knowledge. Overall, it can be observed that the studies on learning styles are aimed at determining the learning styles of students at various grade levels, the effect of teaching based on students' learning style preference on their academic success, their attitudes towards the course and the permanence of the learned knowledge.

The effects of students' preferred learning styles on learning outcomes \ in mathematics and other courses have been addressed in some studies. Different from these studies, the effects of analogy-supported mathematics teaching were also examined in terms of learning styles in the present study. The current study was conducted particularly to find an answer to the following question: "Does the effect of visual analogy-supported teaching of the subject of integers on the sixth-grade students' level of conceptual understanding and their views on analogy use differ according to their learning styles?"

Concepts related to integers are among the basic concepts for mathematics lesson. In order to understand a concept, it is necessary to establish a relationship between the acquisition of basic knowledge and the components that make up that concept. In this process, teachers can make the conceptual learning process more effective by applying teaching methods appropriate to the different learning paths that students prefer. In this respect, the learning style students have may somehow affect the conceptual learning state and other cognitive and affective processes (Ferrer, 1990). Therefore, it would be beneficial to examine the variables, one of which may be learning styles, that affect students' performance in learning mathematics when visual analogy is used. When the related literature was examined, there was no national study to determine whether a relationship between students' learning styles and their performance existed in the analogy-supported teaching process. Based on this deficiency in the literature, the present study aims to examine the effect of visual analogy-supported mathematics teaching of the subject of "integers" on the sixth-grade students' conceptual understanding levels and whether this is mediated by students' learning styles. It also aims to examine whether students' views on analogy use varied depending on their learning styles. As a result, it is considered that this study will contribute to both national and international literature.

Sub-problems

The aim of this study is to determine the effects of visual analogy-supported teaching of integers on the sixth-grade students' conceptual understanding levels and their views on analogy-supported mathematics teaching and to evaluate them in terms of learning styles.

For this purpose, answers to the following research questions were sought:

1. Do the pre-test and post-test scores of the concept understanding test of the students participating in the study differ significantly?

2. Do the pre-test and post-test scores of the concept understanding test of the students participating in the study differ significantly according to their learning styles?

3. Do the results of the visual analogy-supported mathematics teaching assessment form of the students participating in the study differ significantly according to their learning styles?

Method

In this study, a "single group pre-test-post-test" model was used to determine whether the students benefited equally from the visual analogy supported learning method according to their learning styles. The model was applied to a randomly selected group by taking pre-test and post-test measurements (Karasar, 2005) and the results were used to examine whether the difference between two related sample means is significantly different from zero (each other). When the measurements of the same subjects regarding the dependent variable are taken before and after the experimental procedure, these measurements are related to each other (Büyüköztürk, 2006). In the study, the conceptual knowledge levels of the students were measured twice, once before and once after applying analogy-supported mathematics teaching.

Study Group

The study group consists of a total of 52 sixth grade students studying in two different classes of a secondary school in the western part of Turkey. Both classes took part in the research as the study group. The necessary official permission was obtained before commencing the study.

Data Collection Tools

Barsch Learning Style Inventory

The Barsch Learning Style Inventory has been determined as an appropriate data collection tool in terms of its suitability to the student level and determining the learning style. It consists of 24 Likert-type items to determine "visual, auditory and kinesthetic learning styles" (Tekaz, 2004). The learning style of the student was decided according to the highest score obtained from the items in each subsection of the inventory. The Barsch Learning Style Inventory is a valid measure of learning styles as it has also been used by many other researchers (Barsch, 1996; Beck, 2007; Doyran, 2000; Halsne & Gatta, 2002). In the current study, the Cronbach Alpha coefficient of this inventory was found to be 0.60. Its validity was assessed by two subject matter experts who took the view that the Barsch Learning Style Inventory (1996) had the simple language and format and that a great number of learners can digest it without any help. Eventually, they concluded that the inventory was valid because it possesses face validity and content validity.

Concept Understanding Test

Preferring open-ended questions allows students to answer freely without limiting their answers, while reducing the probability of random correct answers to the questions. For this reason, a "Concept Understanding Test" was prepared by the researcher using open-ended questions in order to determine the level of understanding the concepts of integers. The questions were prepared with the concepts of integers. (Negative integer, positive integer, absolute value concept, notion of addition, notion of subtraction, commutative property, associative property, identity element, inverse element). The students were asked to explain and exemplify these concepts. In order to assess its validity, the researcher had face to face consultation with the two subject matter experts. Taking face validity and content validity, into consideration, they agreed on its validity.

In the evaluation phase, the scoring criteria proposed by Abraham, Williamson and Westbrook (1994) were used after certain modifications. In the original version, there were five different categories: sound understanding, partial understanding, partial understanding with specific misconception, specific misconceptions, no understanding. However, the evaluation in the current study was made in four different categories as sound understanding, partial understanding, specific misconceptions, no understanding. partial understanding with Specific Misconception and Specific Misconceptions categories were evaluated as a single category within the scope of this study; because together with the expert opinion, it was presumed that for the concepts at the secondary school level it is appropriate to consider these titles together. Responses in the sound understanding, partial understanding, partial understanding with specific misconception, specific misconceptions, no understanding categories were scored with 3, 2, 1, 0 points, respectively. In the concept understanding test of integers with 10 questions, the highest score a student can get is 30. Below are the characteristics of the answers in each category.

Table 2

The Characteristics of the Answers

Sound Understanding:	Responses that included all components of the validated response.
Partial Understanding:	Responses that included at least one of the components of validated response, but not all the components.
Specific Misconceptions:	Responses that included illogical or incorrect information.
No Understanding:	Repeated the question; contained irrelevant information or an unclear response; left the response blank

Visual Analogy Supported Mathematics Teaching Evaluation Form

This assessment form is a five-point rating type scale specially prepared for this study. It consists of questions about students' impressions and self-evaluation of mathematics teaching supported by visual analogy. The questions are about students' self-evaluation of their learning and all of the questions are in the relevant table in the findings section. The pilot study was carried out within the scope of the thesis by Dinçer (2019), and the scale items were created through observing the students' reactions to analogies by the researcher. Later, within the scope of this study, the scale items were narrowed down and only the items for self-assessment were examined. This evaluation form was examined by two domain experts. They stated that the questions were appropriate for the level of the student and the purpose of measurement.

Data Analysis

The content analysis method was used to analyze the data obtained from the answers that students gave to ten mathematical concepts/operations in the Concept Understanding Test. The main purpose in content analysis was to reach the concepts and relationships that can explain the collected data. In content analysis, the data were analyzed in depth and themes were revealed (Yıldırım & Şimşek, 2011). In the study, the data obtained were compared in terms of similarity and differences as a result of the coding made by the two encoders and the percentage of reliability between the scores was calculated by using the formula (Reliability = consensus / consensus + dissidence) developed by Miles and Huberman (1994). The reliability among the raters was found to be 87% by comparing similarities and differences.

The normality distribution of the groups was evaluated with the Kolmogorov Smirnov test since the size of the groups was greater than 50 (Büyüköztürk, 2006).

Because the groups were not distributed normally, the nonparametric Wilcoxon Signed Ranks Test was used for the first sub-problem in which the Conceptual Understanding Test scores were included.

To answer the second sub-problem of the study, it was examined whether the pretest-posttest results of the conceptual understanding form scores differed according to learning styles. For this purpose, the Kruskal-Wallis H test was used in the analyses between the groups. The Mann Whitney U test was performed to determine which learning style caused the difference between the groups. In the third sub-problem of the study, it was examined whether the results of the visual analogy-supported mathematics teaching assessment form of the students differed according to their learning styles. For this purpose, the Kruskal-Wallis H test for analysis between groups was used. Frequency and percentage calculations were used to determine the number of students with specific styles and rates. The significance level of 0.05 was taken as the basis for analyzing and interpreting the results obtained in the study.

Procedure

The researcher created analogies in the digital environment by establishing daily life connections for integers in line with her interest and the training she received as well as guiding sources in the literature. The reason why analogies were transferred to digital media, not just verbally, was to attract students' attention visually. Because it is aimed here to reveal the learning differences between students with visual and auditory learning styles. Within the scope of this research, ten original analogy supported teaching materials were prepared. These contents were examined by two experts in terms of suitability for the level of the students and content, and content validity was ensured. Since the content and preparation steps of the analogies are the subject of a different study, only the learning style dimension was included in this study.

In the study group, the lessons were taught by the researcher for 16 lesson hours. The subject of integers was taught for approximately 3 weeks, 5 lesson hours per week. In the research, first the concept understanding test was applied as a pre-test, and then visual analogies for the integers were presented. Finally, examples related to the subject were solved, the Concept Understanding test was re-applied as a post-test and the visual analogy supported mathematics teaching evaluation form was administered.

The prepared analogies were presented to the students with a smart board. During the implementations, student behaviors were also observed by the researcher.

Results

To investigate the difference between the pre-test and post-test scores of the students' concept understanding test, descriptive analyses were run. The descriptive statistics about the students' concept understanding test scores are given in Table 3.

Table 3

Descriptive Statistics of the Concept Understanding Test

Test	*N*	*X*	*s*	Min	Max
Pre-test	52	0.90	2.30	0.00	6
Post- test	52	18.59	6.20	4.00	30

In Table 3, the pre-test mean score for the integers area of the concept understanding test of the students was 0.90, whereas the post-test mean score was 18.59.

The scores of the students from the concept understanding pre- and post-tests were analyzed with the Wilcoxon Signed Ranks Test. The results are given in the Table 4.

Table 4

Wilcoxon Signed-Rank Test Results for Comparing the Concept Understanding Pretest-Post-test Scores

Group	*N*	Mean Rank	Sum of Ranks	*Z*	*p*
Negative Ranks	1	2.00	2	-6.259	0.00
Positive Ranks	51	26.98	1376.00		
Ties	0				

As can be seen in Table 4, the Wilcoxon Signed Rank Test indicated a statistically significant difference between the pre-test and post-test scores of the students ($Z = -6.259$, $p < 0.05$). Considering the sum of ranks of difference scores, this difference was in favor of the positive ranks and post-test.

To investigate the pre-test and post-test scores of the students according to their learning styles, the Kruskal- Wallis H test was performed.

Table 5 shows the results of the Kruskal-Wallis H test, which was conducted to compare the pre-test results of the students according to their learning styles.

Table 5

Kruskal Wallis H Test Results of the Pre-Test Scores According To The Learning Styles

Learning Style	***N***	**Xorder**	***SD***	***χ2***	***p***
Visual	22	31.43	2	4.69	0.09
Auditory	19	22.11			
Kinesthetic	11	24.23			

As can be observed in Table 5, according to the results of the Kruskal Wallis-H test conducted to determine whether the mean rank of the pre-test scores differed significantly according to the learning styles, there was no significant difference between the mean ranks of the groups ($p > .05$).

In Table 6, after applying the visual analogy-supported teaching method, the Kruskal-Wallis H test was performed to determine whether there was a statistically significant difference in the Concept Understanding post-test scores according to the students' learning styles.

Table 6

Kruskal Wallis H Test Results of the Post-Test Scores According to The Learning Styles

Learning Style	***N***	**Xorder**	***SD***	**χ2**	***p***
Visual	22	40.57	2	33.32	0.00
Auditory	19	14.97			
Kinesthetic	11	18.27			

According to Table 6, a significant difference was determined between the post-test scores of the students according to their preferred learning styles ($\chi2 = 33{,}32$, $p < 0.05$). To determine which group benefited more from the instruction, the students' Concept Understanding post-test scores were compared in pairs using the Mann Whitney U test.

Table 7

Mann Whitney-U Test Results of the Post-Test Scores According to The Learning Styles

Learning Style	***N***	**Xorder**	**Σorder**	***U***	***P***
Visual	22	29.70	653.50	17.50	0.00 *
Auditory	19	10.92	207.50		
Visual	22	22.36	492.00	3.00	0.00 *
Kinesthetic	11	6.27	69.00		
Auditory	19	14.05	267.00	77.00	0.23
Kinesthetic	11	18.00	198.00		

As observed in Table 7, the "Mann Whitney-U test" was carried out to determine whether the scores of the Concept Understanding test differ significantly according to the learning styles; it was found out that the post-test scores of visual students were statistically significantly higher than those of both auditory and kinesthetic students.

The results of descriptive analyses conducted about the visual analogy supported mathematics teaching evaluation form of the students are given in Table 8.

Table 9 shows the results of the Kruskal-Wallis H test, which was conducted to compare the visual analogy-supported mathematics teaching assessment form scores of the students according to their learning styles.

As the result of the Kruskal Wallis H test shows, the scores of the visual analogy-supported mathematics teaching assessment form did not differ significantly according to the preferred learning styles of the students. ($\chi 2 = 3.18$, $p > 0.05$).

Table 8

Descriptive Statistics about the Visual Analogy Supported Mathematics Teaching Evaluation Form

Items	*N*	Min.	Max.	Mean	Std. Deviation
I think I understand this topic.	52	1.00	5.00	4.01	.93
I can solve problems on this issue.	52	1.00	5.00	3.86	.84
I can make a connection between this subject and daily life.	52	2.00	5.00	4.34	.68
If I learned this subject again, I would prefer to learn it with the same method.	52	2.00	5.00	4.23	.64
I think the lessons are fun with this method.	52	2.00	5.00	4.40	.66

Table 9

Kruskal Wallis H Test Results of the Visual Analogy-Supported Mathematics Teaching Assessment Form Scores According to the Learning Styles

Learning Style	*N*	Xorder	*SD*	*χ2*	*p*
Visual	22	25.77	2	3.18	0.204
Auditory	19	23.39			
Kinesthetic	11	33.32			

Conclusion

This study examined the effect of mathematics teaching supported by visual analogy for the sub-learning area of integers on the conceptual understanding levels of the sixth-grade students and their views on the use of analogy. The findings showed that there was a significant difference between the pre- and post-test scores in favor of the post-test for the conceptual understanding levels of the students.

While there was no significant difference between the pre-test scores of the students according to their preferred learning styles, a significant difference was found between the post-test scores. In order to specify which groups benefited more from the instruction, the Concept Understanding post-test scores were compared according to the learning styles, and it was determined that the post-test scores of the visual students were significantly higher than those of both auditory and kinesthetic students. It was found that the difference between the post-test scores of the auditory and kinesthetic students was not statistically significant. In this study, it was predicted before the study that students with visual learning style would learn concepts at a higher level as visual analogy supported mathematics teaching was carried out. In this case, there was a similarity between the expected result and the result obtained in the study.

According to this result, since visual analogies are more suitable for transferring conceptual knowledge in mathematics in a contextual manner, mathematics teaching based on this approach increases conceptual learning in all students with audio-visual and kinesthetic learning styles, but it is more effective for students with visual learning style. Based on other studies, it is concluded that the use of analogy is beneficial in terms of conceptual learning, academic achievement, permanent learning and attitude levels both in mathematics and other lessons (Cowan & Cipriani, 2009; Paris & Glynn, 2004).

In the present study, teaching with visual analogies positively affected students' views on visual analogy-supported mathematics teaching as well as conceptual learning, but there was no significant difference in terms of learning styles. The students scored an average of four to five on the Likert-type assessment scale items, and the mean score of only one item (I can solve problems on this subject) was below four and was calculated as 3.86. The reason of this situation could lie in the fact that the "problem" expression in the item root can include many problems in a general spectrum with an uncertain degree of difficulty. From the researcher's point of view, it was observed that the students had a great desire before the presentation of the analogies. The researcher experienced the feeling of production after generating each analogy and thanks to the positive feedbacks from the students; a motivational effect was created for the analogy fictions.

Learning styles correspond to computing activities and are fixed and difficult to change because of biological origin. People often uses them without realizing it. Learning strategies, on the other hand, are various techniques that students employ during learning by taking these features into account. However, since different learning processes require the application of different learning strategies, learning strategies can be diversified or changed if necessary and chosen according to the situation and the purpose of the lesson. An individual can use various strategies provided that they are suitable for his learning style (Babadoğan, 1994). Akkoyunlu (1995) emphasizes that determining students' learning styles has a positive effect on teachers’ choice of methods and techniques to be used in their classes. Similarly, in the education process, teaching models, strategies, principles, and methods and learning styles are important factors that play a key role. Many studies in the literature reveal that using teaching methods suitable for students 'learning styles helps to increase students' academic success. In this respect, understanding the interaction between learning styles and various teaching methods will help to understand the education-teaching process. It also contributes to the development of this process and enable a more effective teaching design (Kumar et al., 2004). In the present study, it was observed how a different teaching method had an effect on students' learning of integers and how this was mediated by different learning styles.

As it is known, knowing the learning style of students prepares the ground for the selection and use of functional and appropriate learning models, strategies, methods and techniques. This situation leads to the exhibition of various organizations and activities for students with different learning styles; it contributes to the improvement of the efficiency, quality and permanence of the education system (Karakuyu & Tortop, 2010). In the same vein, Akkoyunlu (1995) emphasizes that determining the learning styles of students has a positive effect on the choice of teaching methods and techniques to be used by teachers. Similarly, including the present study, several studies concretely reveal that students can learn in different ways, have different individual preferences in receiving and processing information, and that there is a positive relationship between learning styles and various variables, especially academic success (Arslan & Durukan, 2015; Ataseven & Oğuz, 2015; Aydemir et al., 2016; Çelik & Gündüz, 2016; Demir, 2008; Dikmen et al, 2018; Erden, 2017; Sidekli & Akdoğdu, 2018).

When the results of the present study and other studies are evaluated in general, it could be concluded that effective and appropriate lessons plans require taking into account, students' learning styles, the use of visual analogy-supported teaching as well as employing different methods and strategies. Since the level of concept knowledge about integers within the scope of the research increased, it can be suggested to use different teaching methods and techniques, especially analogies, in order to form conceptual knowledge in the basic subjects of mathematics. In addition, it may be suggested to organize seminars or in-service training courses in order to increase the knowledge and skills of teachers, who are in the position of implementing different learning approaches. Finally, as a limitation of the present study and as a suggestion for other researchers a larger sample size can be used to create more generalizable results in the future.

Authors' Note

This study was approved by İzmir Provincial Directorate of National Education (Date and ethical decision number: 28/02/2018- 12018877-604.01.02-E-4236245)

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Altıncı Sınıf Öğrencilerinin Öğrenme Stilleri ve Tam Sayıları Kavramsal Anlayışlarının İncelenmesi

Öz

Bu çalışmada öğrencilerin öğrenme stillerinin matematik dersindeki tamsayılar konusuna yönelik kavramsal anlama düzeylerine ve analoji kullanımına ilişkin görüşlerine etkisinin olup olmadığı değerlendirilmişti. Çalışma kapsamında, ön deneme modellerinden "tek grup ön test-son test" modeli kullanılmıştır. Çalışma grubu 6.sınıf düzeyindeki 52 öğrenciden oluşmaktadır. Uygulama sürecinde öğrencilere öğrenme stili envanteri, kavram anlama testi ve görsel analoji destekli matematik öğretimi değerlendirme formu uygulanmıştır. Nicel verilerin değerlendirilmesinde SPSS paket programı kullanılmış ve nitel veriler içerik analizi tekniği kullanılarak değerlendirilmiştir. Araştırma verilerine göre, öğrencilerin kavramları anlama testi puanları son test lehinedir, öğrencilerin öğrenme stillerine göre son test puanları arasında anlamlı bir fark bulunmuştur. Görsel öğrencilerin son test puanlarının hem işitsel hem de dokunsal/kinestetik öğrencilerden farklı olduğu ve istatistiksel olarak daha yüksek düzeyde olduğu belirlenmiştir. Araştırmanın bir diğer sonucu olarak öğrencilerin görsel analoji destekli matematik öğretimine yönelik olumlu görüş bildirdikleri; ancak görüşlerinin ve öğrenme stilleri arasında anlamlı bir fark olmadığı tespit edilmiştir.

Anahtar Kelimeler: Öğrenme stili, matematik eğitiminde analoji, analoji kullanımı