



## Conceptual Understanding Levels of Students with Different Cognitive Styles: An Evaluation in Terms of Different Measurement Techniques\*

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### ABSTRACT

**Purpose:** This study aimed to determine the conceptual understanding (The Unit of Force) levels of seventh-grade students with different cognitive styles with different measurement techniques and to observe how the conceptual understanding levels measured by different measurement techniques are affected by their cognitive styles.

**Research Method:** The sample of the study, which was a causal-comparative study, consisted of 80 seventh-grade students in a public school in Ankara. To determine the field-dependent/field-independent cognitive style differences of the students, the Group Embedded Figures Test was used. To determine students' conceptual understanding levels two different measurement

techniques were used together. The first of these was the Life Based Concept Test. The test consisted of multiple-choice questions using real-life contexts that the student was familiar with in everyday life. Force Concept Map was another measurement technique used to determine students' conceptual understanding. The data obtained were analyzed with MANOVA, one-way ANOVA and t-tests.

**Findings:** The findings of this research show that there was a significant difference concerning conceptual understanding levels measured by Life Based Concept Test and Force Concept Map in favor of students with field-independent cognitive style. The results obtained in this context revealed that the conceptual understanding levels measured by different measurement techniques in the unit of force differ according to cognitive styles of the students.

**Implications for Research and Practice:** This study points out that cognitive style differences are an effective factor in student success. This difference in student achievement shows that measurement techniques may lead to a disadvantage/advantage for the student. Therefore, it is recommended to review the studies in which the conceptual understanding is measured by uniform tests in the literature. In addition, researchers are recommended to use multiple measurement techniques that consider students' individual differences to obtain more valid results.

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## Introduction

In the article "Why everyone needs to understand science" Jonathon Garlick (2014), one of the authors of the World Economic Forum [WEF], expressed the importance of understanding science concepts as:

Science is not important only to scientists or those who profess an interest in it. Whether you find fascinating every new discovery reported or you stopped taking science in school as soon as you could, a base level understanding is crucial for modern citizens to ground their engagement in the national conversation about science-related issues (p.2).

Today, the skills expected from an individual learning science concepts have changed. Understanding science concepts requires the ability to be aware of daily life questions and to find solutions to these problems as a global citizen (WEF, 2020). Considering the connection between science and daily life, the dimensions of teaching science at the conceptual level and evaluation of the conceptual knowledge learned are important in terms of the individual understanding the life and producing solutions from the science perspective. Based on this point, we can say that the evaluation of an in-depth conceptual understanding is one of the basic dynamics of science education.

### *Conceptual Understanding and Importance*

Sinan (2007) defined conceptual understanding as in-depth learning in which relationships and similarities between concepts can be clearly demonstrated, these concepts can be transferred to new environments when necessary and can be used to solve problems encountered in daily life. Concerning providing in-depth learning, the structuring aspects of the science curriculum and the classes which constitute the core of teaching are frequently encountered in the literature. Also, when it comes to conceptual understanding, three elements that draw attention in the literature are; teaching science concepts, misconception and concept evaluation (Amir a& Tamir, 1994; Black & William, 1998; Driver, 1983; Gobert & Clement, 1999; Kavanagh & Sneider, 2007; Tregaut & Duit, 2008; Yagbasan & Gulcicek, 2003; Yin, Tomita & Shavelson, 2013). Scott, Asoko & Leach (2007) formulated conceptual understanding as "concepts are basic units of knowledge and that conceptual understanding results when concepts are accumulated, gradually refined, and combined to form ever richer cognitive structures". From this point of view, we can express that developing a conceptual understanding is a process and, in this process, an in-depth understanding is realized by structuring the concepts. Konicsek-Moran and Keeley (2015) stated that concepts are the building blocks of ideas and definitions. And they emphasized that when students have an understanding of a concept, they can (a) think with it, (b) use it in areas other than that in which they learned it, (c) state it in their own words, (d) find a metaphor or an analogy for it, or (e) build a mental or physical model of it. In other words, the students have made the concept their own. In short, if the student can internalize and reflect the concepts, we can say that he/she developed a conceptual understanding. Based on these expressions, developing a solid conceptual understanding in science education is one of the basic dynamics in terms of

transforming science knowledge of students into skills in every field of life. Therefore, developing and monitoring conceptual understanding in the science curricula of nations has an important place.

### *Measuring Conceptual Understanding*

The development of a full conceptual understanding occurs over time and through repeated contact with concepts (Wild, Hilson & Hobson, 2013). In this process, one of the basic dynamics in the development and monitoring of conceptual understanding is the evaluation of conceptual understanding. In this process, one of the complementary dynamics in the development and monitoring of conceptual understanding is evaluation activities developed in accordance with teaching methods (Black & William, 1998; Tokiz, 2013; Yin, Tomita & Shavelson, 2013). When the literature is examined, it is seen that different measurement techniques are used to determine students' conceptual understanding levels. When these studies are examined, it is noteworthy that two-or three-tier conceptual understanding tests (Artun & Costu, 2013; Cetinkaya & Tas, 2016; Haslam & Treagust 1987; Ozbayrak & Kartal, 2012; Sinan, 2007; Putranta & Supahar, 2019; Sen, Yilmaz & Geban, 2018) and multiple-choice concept tests in which the misconceptions in the options take place as a distractor (Ates&Polat, 2005; Kayacan & Selvi, 2017; Park & Liu, 2016) are frequently used. Aykutlu and Sen (2012) identified misconceptions about electrical current among high school students using concept mapping and analogy in addition to gradual tests. In his study, Kalman (2011) used the reflective writing technique through scientific texts related to physics to enable students to learn concepts in textbooks and to determine their level of conceptual understanding. Yorek (2007) determined the conceptual understanding levels of students through their drawings about biology, Unit of Cell. Although current practice in science education encourages the use of multiple means to assess student learning outcomes, the multiple-choice question still plays the primary role in the evaluation of scientific learning among students (Chang, Kuang Yeh&Barufaldi, 2010). In fact, referring to both teaching and evaluation of concepts, Roth (1990) stated that meaningful conceptual understanding in science goes far beyond knowing facts and labels, and rather, conceptual knowledge becomes meaningful only when it can be used to explain or explore new situations. Based on this point, in this research, a concept test based on real-life contexts and concept map were used to determine conceptual understanding. In the Programme for International Student Assessment [PISA] study, which Organization for Economic Co-Operation and Development [OECD] conducts every three years and determines the level of students' science literacy in one dimension, it is seen that a life-based measurement understanding is dominant in science questions. Questions based on real-life contexts can be defined as questions that enable students to link what they learn in class with real life, to organize data, to establish relationships, to do classification activities, to be concrete, personalized, and to require more reading-thinking skills, and to put the student through certain thinking processes (Bellocchi, King & Ritchie, 2011; Lubben, Campbell & Dlamini, 1996; Taasoobshirazi & Carr, 2008; Tekbiyik & Akdeniz, 2008). Benckert and Pettersson (2005) stated that classical science questions idealize science (in a way that is not related to real-life) and therefore,

students and teachers cannot link real life through these questions. In light of all this, this research, a concept test consisting of questions dealing with daily life contexts were used to determine the level of understanding of Force concepts of 7<sup>th</sup>-grade students. And, in the options of the test, misconceptions commonly seen in the literature were used as a distractor.

In this research, another measurement tool used in determining the level of understanding of students about force concepts is the concept map. Thus, it was aimed to draw attention to the drawbacks of measuring conceptual understanding with uniform measurement tools. Novak and Gowin (1984) put forward the idea that "Concept Maps" can be used to make concrete relations between concepts in line with the basic principles of Ausubel regarding meaningful learning, and they emphasized that this schematic tool is important in organizing information, developing high-level thinking skills, and eliminating misconceptions. Concept maps are an easy way to monitor and evaluate the quality of thinking and learning (Cañas, Novak & González, 2006). Researchers, however, pointed out that concept maps are a metacognitive tool and emphasized that concept mapping improves higher-order thinking skills and can, therefore, be used as a powerful assessment tool (Cañas, Novak & González, 2006; Novak, 1990; Novak & Cañas, 2006). In addition, research has shown that when concept map is used as a measurement and evaluation approach, it is effective in revealing students' conceptual knowledge structures according to multiple-choice or standard tests (Hartmeyer, Stevensen & Bentsen, 2018; Markham, Mintzes & Jones, 1994; Ruiz-Primo & Shavelson, 1996; Taber, 2002). Within the scope of this research, the concept map was used as a measurement and evaluation tool to determine students' conceptual understanding in terms of establishing relationships between concepts and explaining these relations.

When the relevant literature is analyzed, the studies in which the concept maps are handled together with questions based on real-life contexts are limited in evaluating the conceptual understanding about the Unit of Force. Besides, one of the most common misconceptions in students in science classes is the Force. When the science curriculum (Ministry of National Education [MoNE], 2017) is examined, the student encounters many of the scientific concepts in the Force Unit for the first time at the 7<sup>th</sup> grade. These science concepts form the basis of the secondary physics course. Therefore, misconceptions about these scientific concepts are important. If there is a misconception, it should be determined and prevented so that the student does not affect the success of science in the future. Indeed, Gunstone and Watts (1985) argue that changing students' pre-thoughts about mechanics is more difficult than changing their thoughts about other fields of science. This is the main reason for choosing the subject of Force in the research.

In this study, this factor is one of the main objectives in measuring students' conceptual understanding in the subject of the force with different measurement techniques. Another reason for the use of different measurement techniques is the individual differences that students have. In education, gender, physical characteristics, socio-cultural-economic-demographic characteristics of the student,

etc. can be mentioned about many different individual characteristics that should be taken into account. Cognitive styles are just one of these individual differences.

### *Cognitive Styles as an Individual Difference*

It is undoubtedly significant to construct teaching methods and environments and to use measurement and assessment approaches appropriate to this structure in learning science at the conceptual level. However, one of the main elements here is the characteristics of the student's individual differences. According to Tokiz (2013), it is a difficult and complex process to understand how students construct knowledge and learn concepts in their minds and therefore, it is recommended to use different measurement methods with their own advantages and disadvantages. Thus, in this research, one of the reasons for the use of different measurement techniques is the individual differences that students have.

From this point of view, in this study, cognitive style differences, which are the interests of many researchers in the field of science and examined their interactions with different variables in the literature (Bahar, 2003; Basse, Umoren & Udida, 2007; Horzum & Alper, 2006; Karacam & Ates, 2010; Kang & Woo, 1995; Ogunyemi, 1973; Ozarslan & Bilgin, 2016; Sari, Altiparmak & Ates, 2013; Scott & Sigel, 1965), are handled. Tinajero and Paramo (1998) emphasized that the earliest research into cognitive styles was carried out by members of the "New Look" movement, a group of psychologists who were concerned that traditional models of perception placed insufficient emphasis on the individual. The concept of cognitive style was introduced for the first time in a study conducted by Allport (1937) with the expression "the name given to the individual in general and as usual to solve problems, think, perceive and remember (p.21)". Sternberg (1997) defined cognition as being aware of and understanding something. The concepts which Sternberg expressed as recognition and understanding are pointed out to a process of mental processing. Sternberg and Grigorenko (1997) emphasized that cognitive styles represent a bridge between cognition and personality, two different areas of psychological research. In addition, studies (Messick, 1982; Witkin, 1977) that point to the difference between cognitive styles and mental (intellectual) abilities in the field, argue that mental abilities are specific to content or area such as verbal or numerical, while cognitive styles intersect with both talent and personality areas. We can say that cognitive styles reflect the organization of knowledge and experience, not mental ability. Knappenberger (1998) stated that Cognitive style has a broad influence on many aspects of personality and behavior, including perception, memory, problem-solving, interest, and even social behaviors and self-concept. Sternberg and Grigorenko (1997) emphasized that the interest in cognitive styles goes back to Jung's research in 1923, who proposed the theory of psychological types still used in the evaluation of styles through the Myers Briggs Type Inventory; however, modern research on the subject began with Witkin's work. Witkin et al. (1971) conducted a series of standardized psychological test development studies, which they called the Group Embedded Figures Test, to classify and define cognitive styles.

Witkin and Goodenough (1981) considered individuals in two ways considering cognitive styles the field-dependent and field-independent. This polar structure, also known as a psychological differentiation, expresses the extent to which a person's perceptual field is dependent on the perceptual field independent of the organization (Sternberg & Grigorenko 1997). It is revised as the individual's recognition of a pattern is strongly dominated by the total organization of the perceptual domain. On the contrary, in the field-independent cognitive style, the individual is more likely to see parts of the field separately from the organized field (Witkin, Oltman, Raskin & Karp, 1971, p.4). According to Jonassen and Grabowski (1993), field-independent students are concept-oriented, analyze concepts and think analytically. Field-dependent students are real-oriented, influenced by the format and shape structure, and think globally. Cognitive styles develop slowly and experientially and cannot be easily changed through special training (Messick, 1982, quoted from Kagan). It is important to reflect the cognitive styles that are emphasized to be a characteristic feature of the education process (Messick, 1982; Sternberg & Grigorenko, 1997). According to Messick (1982), education should be concerned not only with the acquisition of knowledge but also with the way the student thinks and accordingly should use multiple thinking methods for educational outcomes. Depending on the proximity to the extremes of the dimension Tinajero, Lemos, Araújo, Ferrace and Páramo (2012) draw attention that individuals show diverse ways of information processing, which seem to modulate their academic achievement. These differences in the cognitive structure of individuals appear to be a factor affecting academic achievement and different measurement techniques can provide students with advantages or disadvantages compared to cognitive style differences (Ates & Karacam, 2005; Ates & Cataloglu, 2007). Karacam and Ates (2010) determined the level of conceptual knowledge of the students on physics with different measurement techniques (open-ended and multiple-choice questions) and found that the students with field-independent cognitive style were more successful than the students with field-dependent cognitive style. However, in the context of open-ended questions, they stated that there was no significant difference between the achievements of field-independent and field-dependent students. When the literature is examined, it is noted that students with field-independent cognitive style are more successful in conceptual understanding and achievement tests measured by multiple-choice questions (Celik, 2010; Karacam & Ates, 2010; Onyekuru, 2015; Sari, Altiparmak & Ates, 2013).

In this research, two different types of measurement tools were used to determine students' conceptual understanding levels about the Unit of Force. With the Life Based Concept Test, it is aimed to examine the level of students' ability to transfer the concepts they have learned in daily life contexts to other contexts and concepts. The concept map was used to explore the meanings that students have loaded on concepts, and to understand how they establish relationships between concepts of different importance (Kaya, 2003) and between concepts and examples. Thus, it was aimed to draw attention to the need to eliminate the drawbacks in measuring conceptual understanding by uniform tests. In addition, it is tried to observe what kind of results different measurement techniques produce about the conceptual understanding of

students with field-dependent and field independent cognitive styles. This aspect of the research is thought to contribute to the literature.

In the light of all the above, the aim of this research is to determine the conceptual understanding level of seventh-grade students with different cognitive styles by different measurement tools and interpret them according to field-dependent/field-independent cognitive style features.

## Method

### *Research Design*

This study was designed as a causal-comparative study. Causal-Comparative Method included the comparison of samples which differ in critical variables but were comparable (Balci, 1995, p.264). Cohen, Manion and Morrison (1994) stated that in the causal comparison studies, there are at least two groups affected differently from the same situation, or two groups effected and unaffected from the assumed condition. To sum up, to investigate the possible causes and effects of the present situation, these groups were examined concerning some variables. In this study, field-dependent and field-independent cognitive styles of the students were determined and the effects of these variables on the mean scores obtained from different measurement techniques used to determine conceptual understanding was examined. However, causal comparison studies should not be confused with empirical research trying to establish a cause-effect relationship. In the case of causal comparison research, the situation investigated, unlike the experimental researches arises independently from the manipulation of the researcher. The researcher explains the possible causes of this situation and it tries to identify the effectors (Cohen, Manion & Morrison, 1994).

### *Sample*

In this research, the 7<sup>th</sup>-grade students in the school, where the first author was the teacher, were included in the study group with the convenience sampling method. This sampling method is to select the sample from easily accessible and applicable units due to the limitations in terms of time, money and workforce (Buyukozturk, 2012). The reason for working with seventh-grade students was that, according to the science curriculum, students encountered many scientific concepts related to force for the first time at this grade level. In this context, 80 seventh-grade students from four different classes in a public school in Ankara consisted of the sample of this study.

### *Data Collection Tools*

Within the scope of this research, three different data collection tools were used. Because this study aimed to make a comparison according to the cognitive style differences of the students, the cognitive styles of the students were determined and used Group Embedded Figure Test firstly. However, implementation of Life-Based Concept Test and Force Concept Maps was carried out after the teaching of the force unit.

*Group Embedded Figures Test.* To determine the cognitive styles of the students, The Group Embedded Figures Test, a standard test developed by Oltman, Raskin and Witkin (1971) were conducted, was used in this study. This test is still popular today and is preferred by researchers to examine differences from cognitive styles (Karacam & Ates, 2010; Mefoh, Nwoke, Chukwuorji & Chijioke, 2017; Saracho, 1997; Ozarslan & Bilgin, 2016). The content of the test, which was developed to investigate cognitive styles of students' field dependence/field independence, includes 25 questions which require participants to identify simple geometric shapes from complex geometric shapes over a period of time. The test consisted of three parts. In the first part, seven questions were easy and students were expected to practice. The duration of the first part was two minutes. In the second and third parts, there were nine questions with increasing difficulty. For these two parts, students were given five-minute periods. Students' cognitive tendencies were determined according to their answers to 18 questions in the last two sections. The questions in the first part were not included in the scoring because the students were intended to practice. The score can be graded between 0-18 and the students who were of the most correct in determining the simple shape within the complex shape were classified as field-independent and the students with the least correct are classified as field-dependent. In this study, the method formulated by Alamolhodaei (1996) was used to classify the cognitive styles of the students. Alamolhodaei (1996) has developed this method using the components of the methods used by researchers, such as Scardamalia (1977), Case (1974) and Case and Gobersen (1974). Nicolaou and Xistouri (2011) stated that "In order to avoid the different criteria found in the literature for discriminating between field-dependent and field-independent participants, the Alamolhodaei's study uses a statistical technique for the discrimination" (p.5). And so, this method is often preferred because it produces more valid and reliable results in cognitive style researches (Aydin, 2015; Cataloglu & Ates, 2014; Mousavi, Radmehr & Alamolhodaei, 2012). In this method, the students who find more correct shapes than the number obtained as a result of adding one-quarter of the standard deviation of the scores obtained, are classified as field-dependent, and the students who find less correct shape than the number obtained by subtracting one-quarter of the standard deviation from the average are classified as field-dependent. However, the students whose correct shape numbers are found between these two numbers are classified as students with field-intermediate cognitive style. The descriptive statistic of student's scores obtained from the Group Embedded Figures Test determined by the method of Alamolhodaei is presented in the Findings section.

Witkin and colleagues (1971) showed the age-related developmental curve of the Group Embedded Figure Test empirically. According to their study, they found that the independent ability of children between the ages of 8-15 increased, this trend remained stable until the age of 24, and as the age increased, there was a more field-dependent curve in adults. The results of Witkin and colleagues' research show that the test can be applied in a wide range of age groups. Thompson, Pitts and Gipe (1983) conducted research on the applicability of the Group Embedded Figure Test in the fourth, fifth and sixth grades. The results showed that the test was applicable in these age groups. Indeed, there are many studies in the literature where the test is applied



to children between the ages of 9-15 (Alptekin & Atakan, 1990; Chalip, 1979; Chuang, 1999; Jantan, 2014; Roberge & Flexer, 1983; Sharma, 2018).

*Life-Based Concept Test.* The Life-Based Concept Test using real-life contexts was developed by the researchers of this study to determine the students' level of understanding of the concepts of Force. During the development process of the test, firstly literature review was performed and the table of the specification was created to ensure the scope validity of the test. The test was chosen from the literature (Sahin & Cepni, 2011) and was composed of questions prepared by the researchers. The test includes at least two questions for each outcome in the 7th Class Force Unit in the National Science Curriculum. In addition, the misconceptions found in the literature about Force and frequently encountered misconceptions have been used as a distractor in the options in the items of this test. In this context, it is aimed that the test can be used to determine the conceptual understanding levels of students' who have different cognitive style, to transfer the contexts used in the course to other contexts (contexts used in the test) and to reveal misconceptions.

*Life Based Concept Test Validity, Reliability and Item Analysis.* To ensure the validity of the test, the test was examined by 1 (one) science education field expert and 2 (two) science teachers in terms of the suitability of the questions to the outcomes and the level of 7<sup>th</sup>-grade students, and a pilot test with 17 questions was created in line with the feedback. The pilot test was applied to 290 students at the 8th-grade level who learned the "Force" unit at the previous grade level. During the pilot implementation, the issues that the students could not understand were noted and the questions were revised in the context of these notes in the formation of the final test. Cronbach Alpha reliability coefficient, which is the internal consistency coefficient of the data obtained from the pilot implementation of the test, was calculated as 0.71. The difficulty indices of the questions in the test and the discrimination indices calculated by taking the lower and upper groups of 27% were analyzed. When the item analyzes of the test were examined, two items with a discrimination index below 0.29 (Tekin, 2012) were excluded from the test. It was observed that the items with item discrimination indices below 0.29 and removed from the test were also very easy (0.60 to 1.00) or very difficult (0.00 to 0.40) items. Descriptive statistics of the Life Based Concept Test, which was revised after the items removed from the test, are presented in Table 1.

**Table 1**

*Descriptive Statistics of the Concept Test-Revised after the Subtracted Items*

|                             |         |
|-----------------------------|---------|
| Number of Students          | 290     |
| Number of Items             | 15      |
| Mean                        | 6.71    |
| Standard Deviation          | 2,12    |
| Minimum Score               | 2       |
| Maximum Score               | 13      |
| Skewness                    | 0.128   |
| Kurtosis                    | - 0.981 |
| Average Item Difficulty     | 0.57    |
| Average Item Discrimination | 0.43    |

The lowest score of the Life Based Concept Test is 2, and the highest is 13. The mean of the total scores was 6.71 and the standard deviation was 2.12. The skewness coefficient was 0.128 and the kurtosis coefficient was -0.981. Since the central tendency measures are close to each other and the skewness coefficient is within the range of  $\pm 1.00$ , it was seen that the scores did not deviate excessively from the normal distribution, and the test scores were considered to be a normal distribution. The Cronbach Alpha reliability coefficient of the Concept Test, which was rearranged with the items excluded from the test (two items), was 0.77. In addition, it can be said that in the writing of the test items, the items removed from the test do not decrease the scope validity of the test since at least two items were prepared for each acquisition. The Life Based Concept test developed in this framework is a valid and reliable test.

*Force Concept Map.* In this research, the concept mapping technique was used in conjunction with the Life-Based Concept Test to evaluate the level of conceptual understanding, as it is thought to better reflect the difference between students' knowledge structures (Ruiz-Primo, Schultz & Shavelson, 2001). In the research, the method of creating a concept map from scratch was preferred. This method is a method with a low level of orientation, one of the methods of creating a concept map of Ruiz-Primo (2004). The reason for this was that the basic concepts in Force were many in number and the method was considered to be more suitable for the 7th-grade student level. Thus, students were given concepts related to the subject and asked to draw a concept map using these concepts. In addition, network type pattern was preferred from concept map patterns. Network type pattern was preferred because (1) it contains more than one level (2) reflecting complex interactions at different conceptual levels and thus high integrity (3) adding one or more concepts does not require changing the map much because there are different ways (4) It is possible to reorganize when it is necessary to reflect a wider worldview or to add a missing link (Unlu, Ingeç&Tasar, 2006 quoted from Kinchin, Hay and Adams). According to the protocol proposed by Ruiz-Primo, Schultz and Shavelson (1997a), the students were given 2 hours of training about Concept Maps during the preparation and application of network concept maps preferred as a measurement technique within the scope of this research. A sample concept map about the Cell was drawn and feedback was given. In this research, the Force Criterion Concept Map developed by Aydin Ceran (2018) was used. In determining the concepts of force, four field experts (one science education field expert, two science teacher and one physics teacher) were asked to choose basic concepts from different sources. A concept pool was created from these concepts and 12 concepts (Mass, Weight, Force, Newton, Dynamometer, Pressure, Solid Pressure, Surface Area, Liquid Pressure, Gas Pressure, Mass Gravity Force, Gravitational Force) with the highest frequency were selected (Aydin Ceran, 2018). Students were given only 12 concepts and asked to create a concept map with these concepts. The Criterion-Map Relational Scoring Method (McClure, Sonak & Suen, 1999) was used to evaluate concept maps drawn by students. This scoring method was preferred in many studies where concept maps were used as a measurement tool (Ingeç, 2009; Lee, Jang & Kang, 2015; Rye & Rubba, 2002; Yin, Vanides, Ruiz-Primo, Ayala& Shavelson, 2005). The highest 66 points can be obtained according to the concept map. The students were given 25 minutes to create a concept map.

*Reliability and Validity of Concept Maps.* McClure et al. (1999) state that there are three sources of error that may affect reliability when concept maps are used as a measurement tool. These; Students' experiences in creating concept maps are different, the subject area information differences between the evaluators and the differences between the ratings of the evaluators. Within the scope of the research, in order to minimize these three sources of error, a 2-hour lesson was given to students about concept maps and a sample concept map was drawn. Thus, the stages that the students had difficulties were observed and efforts were made to eliminate them. The concept maps of the Force drawn by the students were evaluated by the one expert in science education and one science teacher. In order to ensure reliability, which can be expressed as the consistency of the scores obtained from the concept map, the inter-rater consistency is generally considered (Ruiz-Primo & Shavelson, 1996; Ruiz-Primo et al., 1997b). In order to provide rater reliability in the evaluation of force concept maps, student scores were scored by two raters according to the relational scoring protocol and the scoring reliability was tested. Independent groups t-test was performed for the significance of the difference between the points assigned by the raters in the evaluation of the Force Concept Maps. The findings are presented in Table 2.

**Table 2**

*Force Concept Map Inter-rater t-Test Results*

|         | <i>N</i> | <i>X̄</i> | <i>S</i> | <i>t</i> | <i>sd</i> | <i>P</i> |
|---------|----------|-----------|----------|----------|-----------|----------|
| Rater 1 | 71       | 22.24     | 2.79     | .351     | 140       | .854     |
| Rater 2 | 71       | 21.92     | 2.84     |          |           |          |

According to Table 2, there is no significant difference between the scores assigned by both raters [ $t(140) = 0.453, p < 0.05$ ]. In addition, the Correlation Coefficients among the Scores Assigned by the Raters were also examined and found to be 0.988.

In ensuring the validity of the force concept map, content validity, criterion validity and structure validity were taken into consideration. In the concept maps, Ruiz-Primo and Shavelson (1996) state that the scope validity can be ensured by the conformity of the concepts to be used in creating the map and the concepts covering the whole structure of the subject. In this regard, to ensure concept-subject integrity, the validity-tested concept map and force concepts (12) were used (Aydin Ceran, 2018). For criterion validity in concept maps, the correlation of concept map scores and scores obtained from another measurement tool whose validity and reliability have been proven should be examined (Ruiz-Primo & Shavelson, 1996; Ruiz-Primo et al., 1997b). In the literature, it is possible to come across many studies that determine the criterion validity of concept maps according to the correlation with standard tests (Conradty & Bogner, 2012; Liu and Hinchey, 1996; Novak, Gowin & Johansen, 1983; Rye & Rubba, 2002; Unlu, Ingec& Tasar, 2006). In this study, Pearson Correlation Coefficients between total scores obtained from concept maps and Life Based Concept Test scores were examined and found to be 0.89.

*Data Analysis*

The data obtained from the data collection tools were analyzed by One Way MANOVA, one- way ANOVA and t-test method, and analyzes were presented in the Findings section.

**Results***Findings from the Group Embedded Figure Test*

The descriptive statistic of student's scores obtained from the Group Embedded Figures Test determined by the method of Alamolhodaie (1996) is presented in Table 3.

**Table 3***Mean and Standard Deviation of Data Obtained from the Group Embedded Figures Test*

| <i>number of students</i> | <i>maximum score</i> | <i>minimum score</i> | <i>M</i> | <i>SD</i> |
|---------------------------|----------------------|----------------------|----------|-----------|
| 80                        | 18                   | 1                    | 7.83     | 4.53      |

According to Table 3, the number of correct answers based on determining the cognitive styles of the students is determined as - the correct answer between 0-6 is field-dependent, 7-8 correct answers are field- intermediate, 9-18 correct answers are field independent. In this context, the findings of the students classified according to their cognitive styles were given in Table 4.

**Table 4***Number of Students by Cognitive Styles*

| <i>number of students</i> | <i>field-dependent</i> | <i>field-independent</i> | <i>Field-intermediate</i> |
|---------------------------|------------------------|--------------------------|---------------------------|
| 80                        | 34                     | 37                       | 9                         |

In the scope of this study, as several researchers used before, in the context of making a comparison between field-dependent and field-independent cognitive style students, field- intermediate cognitive style students were not included in the analysis (Alamolhodaie, 1996; Ates & Cataloglu, 2007). Thus, the result of the analysis, research was carried out with 71 students (34 field-dependent and 37 field-independent).

*Findings Regarding the Assumptions of the MANOVA*

To test the significant difference between Life Based Concept Test and Force Concept Map scores, according to field-dependent and field-independent cognitive style, was analyzed by one-way MANOVA. Before starting the analysis, the assumptions of the One-Way MANOVA analysis were tested for one independent (cognitive style) and two dependent variables. Box's M test was conducted to examine the distribution of covariance matrices. The test results showed that MANOVA analysis could be performed and variance-covariance matrices of dependent variables were evenly distributed (Box's M = 3,400,  $p > .05$ ). Thus, the assumption of equal distribution of covariance matrices, one of the basic assumptions of multiple variance

analysis, was met. The Levene's test results for the homogeneity of variances are presented in Table 5.

**Table 5**

*Levene's Test Results for Homogeneity of Variances*

| <i>Dependent Variable</i> | <i>sd1/sd2</i> | <i>F</i> | <i>P</i> |
|---------------------------|----------------|----------|----------|
| Life Based Concept Test   | 1/69           | ,701     | ,408     |
| Force Concept Map         | 1/69           | ,360     | ,557     |

When the values in the table are analyzed, it is seen that Levene F test values related to the assumption of whether the variances are equal for each dependent variable are greater than the limit value of 0.05. This value shows that there is no significant difference between the groups in the distribution of the error variances of the dependent variables and the variances are homogeneous.

*Findings Related Conceptual Understanding Level of Students with Field-dependent and Field-Independent Cognitive Styles*

The results obtained from the one-way MANOVA analysis of the scores obtained from Life Based Concept Test and Force Concept Map of the students with field-dependent and field-independent cognitive styles are given in Table 6.

**Table 6**

*MANOVA Results of Life Based Concept Test and Force Concept Map Scores according to Cognitive Styles*

| <i>Effect</i>   | <i>Wilks' λ</i> | <i>F</i> | <i>Hypothesis sd</i> | <i>Error sd</i> | <i>Sig.</i> |
|-----------------|-----------------|----------|----------------------|-----------------|-------------|
| Cognitive Style | 0.700           | 7.910    | 2                    | 68              | 0.001       |

MANOVA results revealed that students with field-dependent and field-independent cognitive style showed a significant difference in terms of conceptual understanding scores measured by different tests [Wilks Lambda ( $\lambda$ ) = 0.701, F (2, 68) = 7.910, p <.05]. This finding showed that the scores obtained from the linear component consisting of the Life Based Concept Test and Force Concept Map scores differed depending on the cognitive style differences.

The results of one-way analysis of variance on Life Based Concept Test and Force Concept Map scores according to cognitive styles are presented in Table 7.

**Table 7**

*Life Based Concept Test and Force Concept Map Scores of Students with Different Cognitive Styles One Way Analysis of Variance Results*

| Test                          | Cognitive Styles     | N  | M     | SD   | Sd   | F     | p     |
|-------------------------------|----------------------|----|-------|------|------|-------|-------|
| Life-Based<br>Concept<br>Test | Field-<br>dependent  | 34 | 5.58  | 1.71 | 1-69 | 2017  | 0.000 |
|                               | Field<br>Independent | 37 | 10.10 | 2.22 |      |       |       |
| Force<br>Concept<br>Map       | Field-<br>dependent  | 34 | 21.64 | 8.69 | 1-69 | 31.29 | 0.000 |
|                               | Field<br>Independent | 37 | 39.13 | 9.11 |      |       |       |

In Table 7, one-way analysis of variance results, which are realized as per having the field-dependent and field-independent cognitive styles on Life Based Concept Test and Force Concept Map scores are given. When these values are considered, it was observed that the mean scores of the students who had the field-independent cognitive style from both test types were significantly higher than the mean scores of the students with field-dependent cognitive style the scores in terms of Life Based Concept Test [ $F(1, 69) = 20.17, p < .05$ ] and Force Concept Map mean scores [ $F(1, 69) = 31.29, p < .05$ ].

### Discussion, Conclusion and Recommendations

The findings obtained from this study showed that students with field-independent cognitive style were significantly more successful than the students with field-dependent cognitive style statistically in terms of scores obtained from both Life Based Concept Test and Force Concept Map. When the findings of the related literature are examined, it is seen that the students with field-independent cognitive style in science have a higher level of achievement in terms of conceptual understanding and achievement than the field-dependent students (Al-Naeme, 1991; Altıparmak, 2009; Ates & Cataloglu, 2007; Ates & Karacam, 2005; Cataloglu & Ates, 2013; Crow & Piper, 1983; Celik, 2010; Ozarslan & Bilgin, 2016; Prayekti, 2015; Stamovlasis, Tsitsipis & Papageorgiou, 2009; Ziane, 1996).

In the scope of this research, The Life Based Concept Test is in a multiple-choice format. It has been demonstrated by various studies that the test structure is a factor affecting students' achievement due to individual differences (Celik, 2010; Karacam & Ates, 2010; Sari, Altıparmak & Ates, 2013). With this dimension, the results of this research coincide with the findings of the relevant literature. Witkin et al. (1977) attributed the success of the field-independent students to be more in multiple-choice tests that students of this cognitive style were able to recognize unstructured problems, incorrect structures in activities, and unclear clues to problems. On the other hand, Ozarslan and Bilgin (2016) stated that some of the techniques to be used in the measurement and evaluation process, where student achievement is determined, may offer students an equal chance and help eliminate the advantages which may arise from cognitive differences. The items in the Life Based Concept Test used in the research were developed based on real-life contexts. Thus, it is aimed to determine the

conceptual understanding levels of students based on establishing a concept-context relationship by placing science concepts into familiar daily life contexts. It is stated by various researchers that life-based questions are quite effective compared to classical science questions in terms of attracting students' interest, concretizing science concepts, transferring the context learned in different contexts and observing to what extent the student can use the concepts in daily life (Ahmed & Pollitt, 2007; Heller & Hollabaugh, 1992; Cepni, 2016; Park & Lee, 2004; Tekbiyik & Akdeniz, 2010). Today, it is obvious that the science questions should be designed in a structure that measures higher-level thinking skills, shows what the student knows and can do and is related to daily life (OECD, 2019). However, this study shows that even if the questions are created with real-life contexts, multiple-choice questions provide students with the independent cognitive style taking advantage of the test structure.

In addition, the structure of the questions included in The Life-Based Concept Test may also have caused this finding. If we evaluate this finding within the scope of the skills that Life-Based Concept Test aims to measure, we can say that; students who have field-independent cognitive styles are more successful than field-dependent students in using the concepts of force in their daily life problems or real-life contexts. Tinajero and Paramo (1998) evaluated research in the field dealing with the relationship between cognitive styles and science achievement and stated that the difference between the science achievements of students in field-dependent/field-independent cognitive style may be due to the type of content to which it refers. Today, however, it can be said that current studies that reveal the relationship between new generation science questions (such as PISA science questions) and cognitive styles are needed.

Another measurement tool used in determining the conceptual understanding of the research is the Force Concept Map. Results in terms of scores obtained from Concept Map; field-independent students have higher scores than field-dependent students. When the relevant literature in the field of science education was examined, no research investigating the relationship between concept maps as a measurement tool and cognitive styles was found. However, there are studies examining this relationship in different disciplines (Graff, 2005; Jablokowet al, 2015). In addition, in his study, Abayomi (1989) used concept maps as a learning method for eighth-grade students in science class. When the concept map is used as a learning method, it has reached the end that there is no significant difference between field-dependent and field-independent. Karacam (2005) in the research that students measure their understanding of Force and Motion concepts with different test formats; It was found that Structured Grid Technique, which aims to exhibit the conceptual structure (Bahar, 2001) does not make a significant difference between field-dependent and field-independent students. Hay and Kinchin (2006) emphasized that the most important feature of concept maps is "reveal the structure, organization, and elaboration of understanding". They also point to the need to increase the studies for the integration of cognitive styles, which is a psychometric feature with concept mapping methods. The findings of this study showed that students with a field-independent cognitive style were more successful in concept mapping. This may be due to cognitive style

features or may be due to the content and concept mapping method. The scarcity of studies combining concept maps and cognitive differences in the field of science education and especially in primary school limits the interpretation of the findings obtained from this research. Therefore, the features of cognitive styles were focused on discussing the findings obtained from the research.

When the concept map is used as a measurement tool, this research showed that field-independent students were more successful in establishing the relationships between concepts in the field of Force, defining these relationships and revealing the conceptual structure related to the subject. In this research, only the concepts list about force were given in order that the students should create a concept map concerning the subject and were expected to form the relationships between the concepts and propositions. Thompson (1988) stated that field-independent students could select information from unstructured knowledge areas, from hypotheses to concepts and understandings they carry; they are more advantageous in concept learning in which relevant and irrelevant features are compared and they are more successful in perceiving and synthesizing parts of the whole. And also, Wang and Jonassen (1993) stated that field-independent learners generally prefer to impose their own structure on information rather than accommodate the structure that is implicit in the materials. In the Handbook of Individual Differences, Jonassen and Grabowski (1993) stated that individuals with field-independent cognitive style are more successful in creating a new structure and analyzing the concepts, and also claim that these individuals are less affected by the format and shape structure, they are concept-oriented and analytical. These characteristics may be a reason for independent students to be more successful than field-dependent students in establishing new conceptual structures in concept mapping. Therefore, when it comes to conceptual understanding measurement, it can be thought that concept maps contain findings parallel to multiple-choice test results.

Brooks and Brooks (1999) state that while we have considerable control over what we teach as teachers, we have much less control over what students learn and the reason for this is that each student builds his or her own meaning through their own cognitive processes. Teaching methods, assessment and evaluation approaches, in-class and out-of-class environmental factors confront us as the main factors that affect student achievement in shaping teachers' effective teaching process. However, the results of this research reveal that individual differences the students have are another important factor affecting student achievement.

### **Recommendations**

Findings obtained from the Life Based Concept Test of this study showed that students with field-independent cognitive style are more successful than the field-dependent in the questions prepared using real-life contexts. Even if the questions are based on real-life contexts, multiple-choice test structure provides an advantage to field independent students. This may also be related to the contextual structure of the life-based concept test. However, in the literature, the lack of life-based questions and research on the interaction of individual differences limits the interpretation of this



finding. Thus, researchers may be advised to carry out research that deals with new generation science questions and different cognitive style features.

It was observed that students with field-independent cognitive style were more successful in establishing relationships between science concepts and establishing correct propositions. Concept maps are frequently used in science education as both a learning and measurement tool. Based on this study, it is possible to say that the cognitive style features affect concept mapping. Thus, it is thought that it is necessary to review the studies measuring conceptual success with concept maps. Based on this, researchers are recommended to conduct research examining the causes of cognitive style interactions with the use of concept maps as a measurement tool in science education.

In summary, the test formats used to determine the level of conceptual understanding affect students' conceptual understanding of force depending on their individual differences. Considering that this difference decreases in open-ended or performance-based measurements, this result indicates the necessity of using different measurement and evaluation techniques at an equal distance for all cognitive style students. In this respect, it is suggested that the findings of this study should be considered in the interpretation of the findings of studies aimed at determining conceptual understanding. Each student's having different psychological, social and physical development characteristics requires individualization of instruction (Ari and Bayram, 2011). The individualization of instruction reveals the necessity to diversity and individualize the assessment and evaluation approaches used both in classrooms and national examinations.

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### **Farklı Bilişsel Stillere Sahip Öğrencilerin Kavramsal Anlama Düzeyleri: Farklı Ölçme Teknikleri Açısından Bir Değerlendirme**

#### **Atıf:**

- Aydın Ceran, S., & Ates, S. (2020). Conceptual understanding levels of students with different cognitive styles: An evaluation in terms of different measurement techniques. *Eurasian Journal of Educational Research* 88, 149-178. DOI: 10.14689/ejer.2020.88.7

#### **Özet**

*Problem Durumu:* Fen Bilimleri ve günlük yaşam arasındaki organik bağ göz önüne alındığında, fen derslerinin kavramsal düzeyde öğrenilmesini sağlamak ve kavramsal bilginin değerlendirilmesi, bireyin derste öğrendiği bilgiyi gerçek yaşamında beceriye dönüştürmesi, bu yol ile hayatı anlaması ve bilim perspektifinde çözüm üretmesi açısından önemlidir. Derinlemesine bir öğrenme olarak tanımlanan kavramsal anlamayı (Sinan, 2007) sağlayacak bir öğretim süreci şekillendirmenin tamamlayıcı bir unsuru ise öğretim yöntemleriyle uygun değerlendirme faaliyetlerinin

tasarlanmasıdır (Black ve William, 1998; Yin, Tomita ve Shavelson, 2013; Tokiz, 2013). Alanyazın incelendiğinde öğrencilerin kavramsal anlama düzeylerini belirlemeye yönelik farklı ölçme tekniklerinin kullanıldığı görülmektedir. Bu araştırmalar incelendiğinde iki veya üç aşamalı kavramsal anlama testleri (Artun ve Coştu, 2013; Çetinkaya ve Taş, 2016; Haslam ve Treagust 1987; Özbayrak ve Kartal, 2012; Sinan, 2007; Şen, Yılmaz ve Geban, 2018) ve seçeneklerinde genellikle kavram yanlışlarının çeldirici olarak kullanıldığı çoktan seçmeli kavram testleri (Ateş ve Polat, 2005; Kayacan ve Selvi, 2017), aşamalı testler ile birlikte kavram haritası ve analogi (Aykutlu ve Şen, 2012), yansıtıcı yazma (Kalman, 2011) ve öğrenci çizimleri (Yörek, 2007) gibi tekniklerinde kullanıldığı görülmektedir. Fen bilimlerinin kavramlar düzeyinde öğrenilmesinde öğretim yöntemlerinin ve ortamlarının yapılandırılması ve bu yapıya uygun ölçme değerlendirme yaklaşımlarının kullanılması önemlidir. Ancak burada önem taşıyan bir diğer ana unsur ise öğretimin merkezindeki öğrencinin bireysel farklılıklarından kaynaklanan özellikleridir. Bu noktadan hareketle bu araştırmada fen bilimleri alanında pek çok araştırmada incelenen öğrenci başarısını en fazla etkileyen ve araştırmalarda farklı değişkenler ile etkileşimi bakımından ele alınan öğrencilerin alan bağımsız/alan bağımlı bilişsel stil (Witkin ve Goodenough, 1981) farklılıkları dikkate alınmıştır (Horzum ve Alper, 2006; Karaçam ve Ateş, 2010; Özarslan ve Bilgin, 2016; Sarı, Altıparmak ve Ateş, 2013). Psikolojik bir farklılaşma olarak ta bilinen bu polar yapı bir kişinin çevredeki algısal alanın organizasyondan bağımsız olarak ne ölçüde bu algısal alana bağımlı olduğunu ifade eder (Sternberg ve Grigorenko 1997). Bireylerin sahip oldukları bu bilişsel yapı farklılıkları ise akademik başarıya etki eden bir faktör olarak karşımıza çıkmakta ve farklı ölçme teknikleri öğrencilere bilişsel stil farklılıklarına göre avantaj ya da dezavantaj sağlayabilmektedir (Ateş ve Karaçam, 2005; Ateş ve Cataloğlu, 2007). Bu araştırmada öğrencilerin kavramsal anlama düzeylerini belirlemede iki farklı türde ölçme aracı kullanılmıştır. Yaşam Temelli Kavram Testi ile öğrencilerin günlük yaşam bağlamlarını ve bu bağlamlar içinde öğrendikleri kavramları diğer bağlamlara ve kavramlara transfer edebilme düzeylerinin incelenmesi amaçlanmıştır. Kavram haritası ise öğrencilerinin kavramlara yükledikleri anlamları keşfetmek, farklı öneme sahip kavramlar arası ve kavramlar ile kavram örnekleri arasındaki ilişkileri nasıl kurduklarını anlamak (Kaya, 2003) amacıyla kullanılmıştır. Literatürde sıklıkla karşımıza çıkan ve kavramsal anlamayı değerlendirmede kullanılan bu ölçme tekniklerinin alan bağımlı ve alandan bağımsız bilişsel stile sahip öğrencilerin kuvvet konusundaki kavramsal anlama düzeylerini belirlemede ne gibi farklılıklar içerdiği ve ne tür sonuçlar ürettiği gözlemlenmeye çalışılmıştır. Araştırmanın bu yönüyle alana katkı sağlayacağı düşünülmektedir.

*Araştırmanın Amacı:* Bu araştırma ile farklı bilişsel stillere sahip yedinci sınıf öğrencilerinin Fen Bilimleri Dersi “kuvvet” konusundaki kavramsal anlama düzeylerinin farklı ölçme teknikleri ile belirlenmesi ve bu perspektifte öğrencilerin farklı ölçme teknikleri ile ölçülen kavramsal anlama düzeylerinin sahip oldukları bilişsel stillerden nasıl etkilendiğinin gözlemlenmesi amaçlanmıştır.

*Araştırmanın Yöntemi:* Bu çalışma bir nedensel karşılaştırma araştırması olarak tasarlanmıştır. Nedensel Karşılaştırma Yöntemi, kritik değişkenlerde farklılık gösteren

ancak karşılaştırılabilir olan örneklerin karşılaştırılmasını içerir (Balci,1995, s.264). Bu çalışmada da öğrencilerin alan bağımlı ve alan bağımsız bilişsel stilleri belirlenmiş, bu değişkenlerin kavramsal anlamayı belirlemede kullanılan farklı ölçme tekniklerinden elde edilen puan ortalamaları üzerindeki etkisine bakılmıştır. Çalışmanın örneklemini Ankara'da bir devlet okulunda yedinci sınıf düzeyinde öğrenim gören 80 öğrenci oluşturmaktadır. Öğrencilerin bilişsel stillerini belirlemek amacıyla Oltman, Raskin ve Witkin (1971) tarafından geliştirilen ve geçerlik ve güvenilirlik çalışması yapılmış standart bir test olan Grup Saklı Figürler Testi kullanılmıştır. Öğrencilerin günlük yaşam bağlarını ve bu bağlar içinde öğrendikleri kavramları diğer bağlara ve kavramlara transfer edebilme düzeyleri ekseninde "Kuvvet" konusundaki temel kavramları anlama düzeylerini belirlemek amacıyla günlük yaşam içerisinde seçilen gerçek yaşam bağlarının kullanıldığı çoktan seçmeli formatta bir kavram testi geliştirilmiştir. Öğrencilerin "Kuvvet" konusuna ilişkin kavramsal anlama düzeylerini ortaya çıkarmak ve bilgi yapıları arasındaki farklılığı daha iyi belirleyebilmek amacıyla (Ruiz-Primo, Schultz ve Shavelson, 2001) kavram haritası diğer bir ölçme aracı olarak kullanılmıştır. Kuvvet konusunun öğretimi tamamlandıktan sonra öğrencilere konu ile ilgili 12 kavram verilmiş ve bu kavramları kullanarak bir kavram haritası çizmeleri istenmiştir. Kavram haritası ile değerlendirme yapılmadan önce öğrencilere Ruiz-Primo, Schultz ve Shavelson (1997a) önerdiği protokol referans alınarak 2 saatlik bir kavram haritası çizme öğretimi yapılmıştır. Öğrencilerin çizdikleri kavram haritaları Aydın Ceran (2018) tarafından geliştirilen ve güvenilirlik ve geçerlik çalışmaları yapılan kriter kavram haritasına göre değerlendirilmiştir. Elde edilen kavram haritalarını puanlandırmak için ise kriter haritalı ilişkisel puanlama yöntemi kullanılmıştır (McClure, Sonak ve Suen, 1999). Yaşam Temelli Kavram Testi ve Kuvvet Kavram Haritası, birinci yazar tarafından kuvvet ünitesinin öğretimi yapıldıktan sonra uygulanmıştır. Araştırmada veri toplama araçlarında elde edilen veriler Tek Yönlü MANOVA, ANOVA ve t-testi yöntemiyle analiz edilmiş ve analizler Bulgular bölümünde sunulmuştur.

*Araştırmanın Bulguları:* Öğrencilerin Grup Saklı Figürler Testinden aldıkları puanların betimsel istatistiklerine göre yapılan değerlendirme sonucunda 34'ünün alan bağımlı, 37'sinin alan bağımsız ve 9'unun ise alan orta bilişsel stilde olduğu belirlenmiştir. Bu çalışma kapsamında ise alan bağımlı ve alan bağımsız bilişsel stile sahip öğrenciler arasında bir karşılaştırma yapmak amaçlanıdığından alan orta bilişsel stildeki öğrenciler analize dahil edilmemiştir. Yaşam Temelli Kavram Testi puan ortalamaları ve Kuvvet Kavram Haritası puan ortalamaları bakımından alan bağımsız bilişsel stile sahip öğrencilerin her iki test türünden aldıkları puanların ortalamalarının alan bağımlı bilişsel stile sahip öğrencilerin puan ortalamalarından istatistiksel olarak anlamlı bir şekilde daha yüksek olduğu gözlenmiştir.

*Araştırmanın Sonuçları ve Öneriler:* Araştırmada kullanılan Yaşam Temelli Kavram Testindeki maddeler gerçek yaşam bağlarına dayalı olarak geliştirilmiştir. Öyleki öğrenciye tanıdık gelen günlük yaşam bağlarını içine fen kavramları yerleştirilerek kavram-bağlam ilişkisi kurma temelinde öğrencilerin kavramsal anlama düzeylerinin belirlenmesi amaçlanmıştır. Yaşam temelli soruların öğrencinin ilgisini çekmede, fen

kavramlarını somutlaştırmada, derste öğrenilen bağlamı farklı bağlamlara transfer etmede ve öğrencinin kavramları günlük yaşamda ne ölçüde kullanabildiğinin gözlemlenebilmesi çerçevesinde klasik fen sorularına kıyasla oldukça etkili olduğu çeşitli araştırmacılar tarafından belirtilmiştir (Ahmed ve Pollitt, 2007; Heller ve Hollabaugh, 1992; Çepni, 2016; Park ve Lee, 2004; Tekbıyık ve Akdeniz, 2010). Bu araştırma kapsamında alan bağımsız bilişsel stildeki öğrencilerin yaşam temelli sorularda daha başarılı olmaları geleneksel anlayış dışındaki kavramsal bilgi içeren fen sorularında da çoktan seçmeli test yapısının alan bağımsız bilişsel stile sahip öğrencilere avantaj sağladığı şeklinde yorumlanabilir. Araştırmada kavramsal anlamının belirlenmesinde kullanılan bir diğer ölçme aracı ise Kuvvet Kavram haritalarıdır. Sonuçlar alan bağımsız öğrencilerin Kavram Haritalarından elde edilen puanlar bakımından alan bağımlılara göre istatistiksel olarak daha yüksek puana ulaştıklarını göstermektedir. Alan yazın incelendiğinde farklı bilişsel stile sahip öğrencilerin kavram haritalarında göstermiş oldukları performansı değerlendiren bir çalışmaya rastlanmamıştır. Fen eğitiminde kavram haritalarının bir değerlendirme aracı olarak sıklıkla kullanıldığı düşünüldüğünde, kavram haritalarının farklı bilişsel stillere ne ölçüde hitap ettiğine yönelik çalışmaların yapılmasına ihtiyaç olduğu açıktır. Genel bir değerlendirme ile kavramsal anlama ölçümü söz konusu olduğunda kavram haritalarının çoktan seçmeli test sonuçlarına paralel bulgular içerdiği düşünülebilir. Öğretmenlerin etkili bir öğretim süreci şekillendirmesinde öğretim yöntemleri, ölçme ve değerlendirme yaklaşımları, sınıf içi ve dışı çevresel faktörler öğrenci başarısını etkileyen temel faktörler olarak karşımıza çıkmaktadır. Ancak araştırma sonuçları öğrencinin sahip olduğu bireysel farklılıkların öğrenci başarısına etki eden bir başka önemli faktör olduğunu ortaya koymaktadır.

*Anahtar Sözcükler:* Alan bağımlı/alan bağımsız bilişsel stiller, kavram haritası, yaşam temelli kavram testi, bilişsel farklılıklar.