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Science Achievement in TIMSS Cognitive Domains Based on Learning Styles

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Abstract

Problem Statement: The interest in raising levels of achievement in math and science has led to a focus on investigating the factors that shape achievement in these subjects. Understanding how different learning styles might influence science achievement may guide educators in their efforts to raise achievement. This study is an attempt to examine primary school students' science performance on Trends in International Mathematics and Science Study (TIMSS) cognitive domains, based on their learning styles. Being aware of learning styles and their influence on different cognitive domains may provide educators with ideas for differentiating instruction and may help improve TIMSS achievement.

Purpose of Study: This study examined the differences in 8th grade students' science scores in terms of the knowing, applying and reasoning domains of TIMSS, based on Kolb's learning styles and the relationship among learning modes and the TIMSS domain scores.

Methods: A science test developed from the released TIMSS items measured 8th grade science achievement, and Kolb's Learning Style Inventory (LSI) determined the preferred learning styles. Relationships among students' learning mode and dimension scores and domain scores were examined through a bivariate correlation analysis. Differences in the total science scores of students in four types of Kolb's learning styles were examined through Analysis of Variance (ANOVA). Next, Multivariate Analysis of Variance (MANOVA) was conducted to examine the differences in knowing, applying, and reasoning domain scores based on learning styles.

Findings and Results: The results showed that assimilating and converging learners were consistently more successful, while diverging learners were

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the least successful in all three cognitive domains of TIMSS science. The correlation between the Abstract Conceptualization-Concrete Experience dimension score and achievement increased as questions became more complex.

Conclusions and Recommendations: It was concluded that students might need to utilize their abstract conceptualizing skills rather than their concrete experience skills in order to become successful in TIMSS assessments. It is crucial to assess students' learning styles in order to motivate educators to reflect on their teaching styles. There is strong empirical evidence that learners' performance has increased when teaching was arranged according to their learning preferences in higher education. Further emprical evidence is needed for whether learning-style-based instruction described by Kolb improves primary school students' achievement.

Keywords: Kolb's learning styles, TIMSS, science achievement, cognitive domains, abstract conceptualization, concrete experience

Researchers indicate when individuals are aware of how they learn and if teachers respond to individuals' strengths and weaknesses, achievement and retention rates tend to improve (Coffield, Moseley, Hall, & Ecclestone, 2004). Since the early 20th century, numerous theories have been developed on learning styles. Some of these theories have been influential in various disciplines worldwide, such as Kolb's Learning Styles, Dunn and Dunn Learning Styles, and Grasha-Riechmann Learning Style (Coffield et al., 2004). While some of the theories argue that learning styles are mostly stable and are influenced by inherited traits (e.g., Gregorc, 1982), others describe learning styles as the outcome of the dynamic interplay between self and experience (e.g., Myers & McCaulley, 1985). Another group of theorists, such as Kolb (1984), claim that learning styles are flexible and influenced mostly by motivational and environmental factors. Kolb's Experiential Learning Theory is a widely used theory that emphasizes the dichotomy between abstract thinking and concrete experiences, which was the focus of the current study.

Kolb's Experiential Learning Theory

The Experiential Learning Theory (ELT), as developed by David Kolb in the early 1970s, has been influential in various disciplines worldwide. In his theory, Kolb suggested that there are four stages in an effective learning cycle, with a different learning mode in each stage: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE) (Kolb, 1984). An individual's learning style is determined by the combination of the four learning modes which stretch into two dimensions. The first dimension is active/reflective. This determines if individuals prefer learning through 'doing' or 'reflecting'. The second dimension is concrete/abstract, one pole of which is 'feeling', in which learners use their senses and emotions, while the other pole is 'thinking' in which they use reason and logic.

In a recent publication, Joy and Kolb (2009) emphasized the importance of abstract conceptualization for some key aspects with regard to cultural well-being and future orientation. Global economic competition demands that educators train learners in improved abstract and critical thinking skills (Lombard & Grosser, 2008). Researchers highlight that individuals with learning styles that specialize in abstract conceptualization (AC) show higher levels of analytical skills (Mainemelis, Boyatzis & Kolb, 2002), show superior performance in completing complex tasks (Bostrom, Olfman & Sein, 1988) and excel in science and mathematics (Kolb & Kolb, 2005b).

According to Kolb's ELT, individuals with abstract conceptualization and reflective observation as dominant learning modes are called assimilators (see Figure 1). They prefer reading, lectures and exploring models in formal learning settings. Assimilators consider the teacher as the leader and information giver (Arthurs, 2007; Kolb, 1984; Sharp, Harb & Terry, 1997). Assimilators are more interested in abstract concepts and putting information in a logical form (Jones, Reichard & Mokhtari, 2003; Kolb & Kolb, 2005b). Individuals with this learning style tend to specialize in mathematics and basic sciences (Kolb, 1981). Similar to assimilators, convergers utilize abstract conceptualization. However, instead of reflective observation, they prefer the active experimentation learning mode. Convergers are good at finding practical uses for ideas and theories and finding solutions to problems (Healey & Jenkins, 2000; Jones et al., 2003; Kolb, 1981). They prefer experimenting, simulations and laboratory assignments. Individuals in this style usually prefer careers in medicine and engineering (Kolb & Kolb, 2005a). They perform better in tests where there is a single correct answer or solution to a problem (Kolb, 1981).

Learners who utilize concrete experience instead of abstract conceptualization as their preferred learning mode are referred to as divergers and accommodators (see Figure 1). Individuals with a diverging style have reflective observation as well as concrete experience -dominant learning modes. They are interested in observing and gathering a wide range of information; they are good at generating ideas and are able to listen with an open mind (Kolb, 1984; Healey & Jenkins, 2000; Jones et al., 2003). These learners are likely to specialize in arts, history, political science, language and psychology (Kolb & Kolb, 2005a). Individuals with an accommodating learning style have concrete experience and active experimentation as their dominant learning modes. Learners in this style are interested in 'hands on' experience (Healey & Jenkins, 2000; Jones et al., 2003; Kolb, 1981). They rely on their feelings rather than logical analysis when it comes to problem solving. They prefer working in groups, doing field work, having new and challenging experiences, and testing different approaches in completing a project. Individuals in this style are likely to choose careers in education, communications, marketing and nursing (Kolb & Kolb, 2005a).

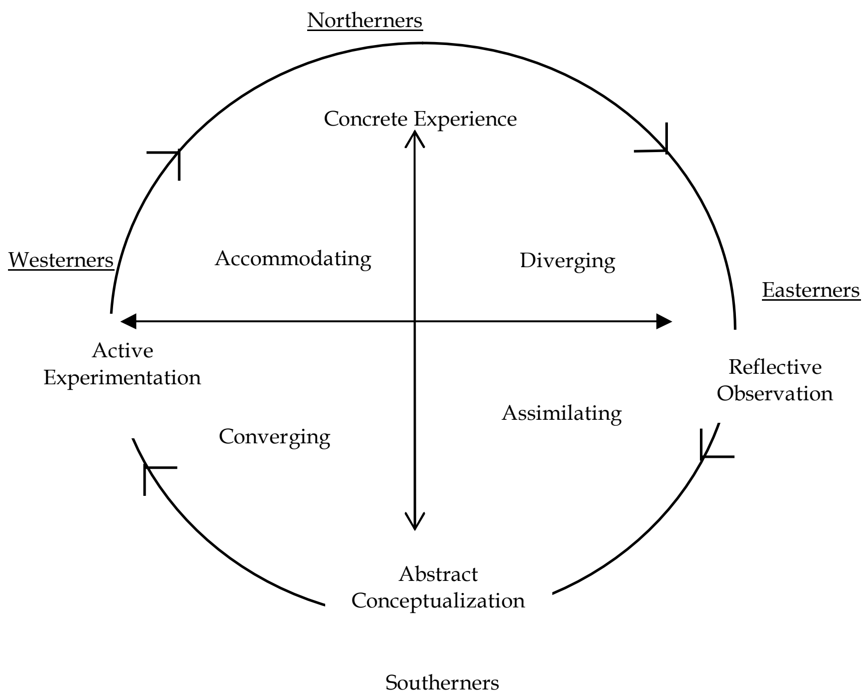

Figure. 1 Kolb's Learning Styles (Adapted from Kolb, 1984)

Recent research on learning differences has focused on learning styles and their effects on academic achievement. The influence of learning styles on achievement is dependent upon subject areas (Jones et al., 2003), instructional methods (Tulbure, 2011) and assessment methods (Holley & Jenkins, 1993; Gurpinar, Alimoglu, Mamakli & Aktekin, 2010; Lynch, Woelfl, Steele & Hanssen, 1998). For example, with medical education students, Gurpinar and colleagues (2010) reported that accommodators were more successful in terms of problem-based learning exams, whereas assimilators were more successful in theoretical block exams. In terms of academic achievement, in general, convergers and assimilators are found to be more advantaged (Boyatzis & Mainemelis, 2000; Jones et al., 2003; Terrell, 2002; JilardiDamavandi, Mahyuddin, Elias, Daud & Shabani, 2011). Specifically in science and mathematics, either convergers (Biçer, 2010; Davies, Rutledge & Davies, 1997; Kurbal, 2011) or assimilators were more successful (Özkan, Sungur & Tekkaya, 2004). In some cases, they were equally successful compared to accomodators and divergers (JilardiDamavandi et al., 2011). These studies indicate that, in general, assimilating and converging students demonstrate better academic performance.

Kolb and Kolb (2005a) describe accomodating and diverging styles as *northern* and assimilating and converging styles as *southern*. The northern learning style integrates the reflective observation/active experimentation dimension and excels in concrete experience. It has the characteristics and abilities of the diverging and accommodating styles. Southerners are flexible in the reflective observation/active experimentation dimension and specialize in abstract conceptualization. They have the characteristics of the assimilating and converging styles (Kolb, Boyatzis & Mainemelis, 2000; Kolb & Kolb, 2005a). Southerners have higher scores in AC and lower scores in CE. In other words, when the AE/RO dimension is controlled, as the CE score increases, the learner falls into the diverging or accomodating quadrant, whereas he/she falls into the assimilating or converging quadrant when the AC score increases. The achievement gap between the southern and northern learning types might be attributed to the AC-CE dimension. In fact, studies investigating the relationship between learning modes and academic performance reported that abstract conceptualization scores were positively correlated with achievement (Arslan & Babadoğan, 2005; Boyatzis & Mainemelis, 2000; Kurbal, 2011; Newland & Woelfl, 1992).

Researchers have utilized learning styles in explaining students' achievement in large--scale nationwide tests (JilardiDamavandi et al., 2011; Kurbal, 2011). With the same notion, it is expected that students' Trends in Mathematics and Science Study (TIMSS) achievement might be related to their learning styles. TIMSS, sponsored by the International Association for the Evaluation of the Education Achievement (IEA), measures the mathematics and science achievement of nationally representative samples of students and collects background information from such students, their teachers, and their schools on a four-year cycle (Martin et al., 2008). There are three cognitive domains in TIMSS assessments: *knowing, applying,* and *reasoning*. There is a hierarchy in the division of behaviors into these cognitive domains, as well as a range of difficulty for items in each of the cognitive domains (Martin, Mullis, Foy & Stanco, 2012). In this respect, the TIMSS cognitive domains show similarities with Bloom's taxonomy. In the original Bloom's taxonomy, the cognitive levels went from simple to complex and from concrete to abstract (Anderson & Krathwohl, 2001). After the revision by Anderson and Krathwohl in 2001, the original cognitive levels became the *cognitive process* dimension. The cumulative hierarchy in categories was removed, but the hierachy from lower to upper remained.

This study is an attempt to examine primary school students' science performance on TIMSS cognitive domains, based on their learning styles. Awareness of learning styles and their influence on different cognitive domains may provide educators with ideas for differentiating instruction and may help improve TIMSS achievement. As TIMSS items range from factual knowledge-seeking to more abstract-reasoning type questions, the relationship between the preferred learning style and achievement might be more apparent as the questions become more complex. We hypothesize that, as the AC-CE dimension score increases, so will the students' achievement on the TIMSS items. Additionally, the achievement gap among learning styles increases as we move up in the hierarcy of TIMSS cognitive domains.

In recent years, reform in science education has been highlighted by influential policy reports (National Academy of Sciences, 2006; National Science Board, 2007).

These reports underline the significance of being successful in the fields of science, technology, engineering and mathematics (STEM) in order for a country to be competitive in the global economy. Scientific and technological advancements will be possible through scientifically literate citizens (Makgato & Mji, 2006). The Turkish goverment also called for action recently to improve the scientific literacy of citizens in Turkey (Milli Egitim Bakanligi, 2005). The interest in raising levels of achievement in math and science has led to a focus on investigating the factors that shape achievement in these subjects (Lamb & Fullarton, 2002). Understanding how different learning styles might influence science achievement may guide educators in their efforts to raise achievement.

Method

Research Design

A correlational research design was used in this study. In correlational studies information is collected without manipulating the environment. Correlational studies are also conducted to demonstrate associations between variables. Causality cannot be inferred (Creswell, 2008). In the current study, the association between learning styles and science achievement was examined.

Research Sample

The participants of this study were 437 8th grade, primary-school students (54% female and 46% male) from five different schools of the Kocaeli (72%) and Istanbul (28%) provinces of Turkey. The data were collected from 20 different classes in these schools. On average, there were 30 students in each class, with an average age of 13. Fifty-four percent of the participants were female, and 46% were male. The tests that were not filled out properly or that have a lot of missing information were not included in the data analysis. None of the schools in the current study had participated in a TIMSS assessment before. All the participating schools were following the national science curriculum and were using the same 8th grade science textbook at the time of the study.

Research Instruments and Procedure

Two instruments were used in this study. The first one was the Kolb's Learning Style Inventory (LSI)-Version 3 (Kolb, 1999). The earlier versions were developed by Kolb in 1971 and 1984. Version 2 was translated into Turkish by Aşkar and Akkoyunlu (1993). The Turkish adaptation of Version 3 was carried out by Gencel (2006), and this version was used with the permission of the author. There are 12 items in the inventory that ask respondents to rank four statements that are related to the four learning modes: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE) (Kolb & Kolb, 2005a).

Contrary to the widely-used Likert scale, the LSI has a forced-choice format in which the respondents rank four learning modes. Due to the forced-choice format, these learning modes are interdependent. Furthermore, the two learning dimensions, AC-CE (perception) and AE-RO (processing) are dialectic; that is, individuals chose between the two opposite poles (Kolb & Kolb, 2005a). Based on their combination scores with regard to AC-CE and AE-RO, students were grouped into four types of learning styles - diverging, assimilating, converging or accommodating.

The second instrument was the science achievement test which was compiled from the released TIMSS items. There were 33 questions in the test, of which three were worth two points, while others were worth one point. Therefore, the highest possible score was 36. The test is composed of three domains: *knowing, applying* and *reasoning*. Knowing questions assess the students' knowledge base in terms of science facts, information and concepts. Students are expected to recall, recognize, define, describe or illustrate related science content. Applying involves the application of scientific knowledge in different situations, and a demonstration of relationships. Problems might be either quantitative or qualitative in nature. Students are expected to classify, compare, contrast, use models, relate, interpret, explain, and find solutions. Finally, the reasoning domain involves more complex scientific tasks. Students may use a variety of strategies to solve such problems. They use skills such as analyzing, synthesizing, drawing conclusions, hypothesizing, generalizing and evaluating (Martin et al., 2008). Since the main purpose of this study was to examine students' science achievement on each cognitive domain, as well as their general science score based on their learning styles, the same number of questions from each domain were included in the science test. Eleven of these questions were from the knowing domain, 11 were from the application domain and 11 were from the reasoning domain.

Data were collected at the end of the 2011-2012 school year from 437 8th grade students attending five schools. In all classes, the science test compiled from the released TIMSS items was administered first, followed by Kolb's LSI. Both researchers were present during all administrations. Participants completed the science test in 45 minutes, and the LSI was completed in 10-15 minutes.

Validity and Reliability

The Turkish version of the Kolb Learning Styles Inventory was used with 13-14 year-old, primary-school students. After the Turkish adaptation of Version 3, the reliability coefficients for the inventory were found to be between 0.71 and 0.84 (Gencel, 2006). As for the second instrument, among 81 released TIMSS items, 33 of them were selected by two curriculum professionals and included in the science assessment. The number of questions in the tests, the numbers from each content domain, and the numbers from each question format, were kept parallel to the original assessment framework. In the original assessment, there were 14 different booklets with 33 to 37 science items in each at the 8th grade level. The number of multiple-choice items were slightly higher than the constructed response items (Ruddock, O'Sullivan, Arora & Erberber, 2008). In the current study, the science test included 33 questions, 17 of which were multiple choice and 16 of which were constructed-response items. The content domains were biology, chemistry, physics and earth science. The reliability coefficient of the mutiple choice items was 0.78. The constructed-response items were scored by each researcher independently by using the TIMSS scoring guide. The results were then compared, and disagreements were resolved through discussion. Constructed-response items were worth one or two points, depending on the task the students were asked to complete. Items were worth one point when students were asked for a brief descriptive response in science, while they were worth two points when students were required to show their work or provide an explanation (Ruddock et al., 2008).

Data Analyses

Statistical analyses of this study were conducted using SPSS 18. Descriptive statistics of the science achievement test and Kolb's learning styles were reported. Bivariate correlation analysis was conducted in order to examine the relationships among students' science scores and dimension scores. Differences in the total science scores of the students in terms of four types of Kolb's learning styles were examined through Analysis of Variance (ANOVA). Next, Multivariate Analysis of Variance (MANOVA) was conducted to examine the differences in knowing, applying and reasoning domain scores, based on learning styles.

Results

Table 1 shows the descriptive statistics for the cognitive domain scores and the total scores on the science test. The average science score was 19.05 (SD=6.79), while the cognitive domain scores were 6.44 (SD=2.63) for knowing, 6.31 (SD=2.46) for applying, and 6.30 (SD=2.80) for reasoning.

Table 1

Descriptive Statistics for the Science Test

		Knowing		***Applying***		***Reasoning***		***Total***	
	n	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Diverging	139	5.88	2.70	5.65	2.70	5.19	2.82	16.71	7.18
Assimilating	116	6.84	2.56	6.89	2.22	7.19	2.60	20.91	6.35
Converging	84	6.98	2.59	6.79	2.12	7.08	2.60	20.85	6.09
Accommodating	98	6.32	2.49	6.14	2.44	6.17	2.62	18.63	6.28
Total	437	6.44	2.63	6.31	2.46	6.30	2.80	19.05	6.79

Bivariate correlation analysis was conducted in order to examine the relationships among students' cognitive domain scores and dimension scores (see Table 2). In general, there were positive correlations between students' total science scores and AC scores ($r=0.302$, $p<0.01$) and AC-CE scores ($r=0.282$, $p<0.01$) and negative correlations between science scores and CE (r=-0.128, p<0.01) and RO scores (r=-0.157, p<0.05). There were no correlations between science scores and AE (r= -0.014) and AE-RO scores (r= 0.087).

Table 2

Bivariate Correlations Between Cognitive Domain Scores and Dimension Scores

	CE	*AC*	*AE*	*RO*	*AE-RO*	*AC-CE*
Knowing	-0.089	0.215**	-0.021	-0.105*	-0.052	0.200**
Applying	-0.078	0.282**	-0.030	-0.162*	0.080	0.238**
Reasoning	-0.158**	0.282**	0.013	-0.139*	0.092	0.287**
Total	-0.128**	0.302**	-0.014	-0.157*	0.087	0.282**

* Correlation is significant at the p<0.05 level, **Correlation is significant at the p<0.01 level

The students' CE scores were only negatively correlated with their reasoning scores (r=-0.158, p<0.01); there were no significant correlations with the knowing and applying domains. AC scores were positively correlated with all three cognitive domains, with the correlation coefficients being higher for applying (r=0.282, p<0.01) and reasoning (r=0.282, p<0.01) compared to knowing (r=0.215, p<0.01). The negative correlations between RO and science scores were significant for all three domains of knowing (r=-0.105, p<0.05), applying (r=-0.162, p<0.05) and reasoning (r=-0.139, p<0.05). Finally, the positive correlations between AC-CE and science scores were significant for all three domains of knowing (r=0.200, p<0.01), applying (r=0.238, p<0.01) and reasoning (r=0.287, p<0.01), and the coefficients increased as the cognitive domains became more complex.

As displayed in Table 3, the analysis of variance (ANOVA) results showed that there are statistically significant differences in the total mean science scores in terms of the different learning styles [F(3,433)=11.21, p<0.01]. In order to determine the differences in science scores among the different learning styles, post-hoc analysis was conducted, and it was found that diverging-type learners (M=16.71, SD=7.18) were the least successful on the science test compared to the other types. In general, the southern learning styles, converging (M=20.85, SD=6.09) and assimilating (M=20.91, SD=6.35) outperformed the northern learning styles, diverging and accommodating (M=18.63, SD=6.28). Finally, the accommodating type outperformed the diverging type in terms of their total science scores. There was no significant difference between the total science scores of the converging and assimilating types.

Table 3

Analysis of Variance (ANOVA) Results of Total Science Score by Learning Styles

	Sum of Squares	*df*	*Mean Square*	*F*	*p*	*Differences**
Btwn. Groups	1450.40	3	483.47			
Within Groups	18673.39	433	43.13	11.21	0.000	2>1, 2>4, 3>1, 3>4, 4>1
Total	20123.79	436				

*1: Diverging, 2: Assimilating, 3: Converging, 4: Accommodating

In examining the cognitive domain scores separately based on learning styles, a multivariate analysis of variance (MANOVA) was conducted. Results showed that there were statistically significant differences in cognitive domain scores based on learning styles [F(3,433)=4.97, p<0.01]. According to the univariate ANOVA results in Table 4, in the knowing domain, students in the assimilating (M=6.84, SD=2.56) and converging styles (M=6.98, SD=2.59) scored significantly higher than students in the diverging style (M=5.88, SD=2.70) [F(3,433)=4.33, p<0.01]. There were no other significant differences among styles in this domain. In the applying domain, the assimilating type (M=6.89, SD=2.22) scored significantly higher than the diverging (M=5.65, SD=2.70) and accommodating types (M=6.14, SD=2.44), and the converging type (M=6.79, SD=2.12) scored significantly higher than the diverging type [F(3,433)=6.94, p<0.01]. There were no other significant differences among styles in the applying domain. In the reasoning domain, southern learning styles, namely, assimilating (M=7.19, SD=2.60) and converging (M=7.08, SD=2.60) were more successful than northern learning styles, diverging (M=5.19, SD=2.82) and accomodating (M=6.17, SD=2.62). Additionally, the accommodating learners outperformed the diverging learners. There was no significant difference between the reasoning scores of the convergers and the assimilators. As indicated by partial eta-squared values, more variance in students' scores is explained by learning-style differences as the cognitive domain becomes more abstract. In other words, the effect size of learning styles increases for more complex TIMSS questions.

Table 4

Univariate ANOVA Results of Cognitive Domain Scores by Learning Styles

	Knowing			***Applying***			***Reasoning***		
	M	*F*	*p*	*M*	*F*	*p*	*M*	*F*	*p*
1.Diverging	5.88			5.65			5.19		
2.Assimilating	6.84	4.33	0.005	6.89	6.94	0.000	7.19	14.73	0.000
3.Converging	6.98			6.79			7.08		
4.Accommodating	6.32			6.14			6.17		
Differences*	2>1, 3>1			2>1, 2>4, 3>1			2>1, 2>4, 3>1, 3>4, 4>1		
Partial Eta Squared	0.029			0.046			0.093		

*1: Diverging, 2: Assimilating, 3: Converging, 4: Accommodating

Discussion and Conclusion

The findings of the present study showed that students with southern learning styles show higher performance on TIMSS items compared to those with northern styles, and the difference between abstract conceptualization and concrete experience becomes more influential as the complexity of questions increases.

In abstract conceptualization, which is dominant in terms of assimilators and convergers, learners focus on analytic theories and abstract concepts to explain events. Abstract, conceptual understanding enables them to transfer knowledge between tasks. They have improved critical-thinking, analytical, evaluative and reasoning skills. Considering the TIMSS, for applying and reasoning items in which students are expected to use different problem-solving strategies and abstract skills such as hypothesizing, analyzing, synthesizing, drawing conclusions, generalizing and evaluating (Martin et al., 2012), it is reasonable that the assimilators and convergers score better on the TIMSS items. Thus, students might need to utilize their abstract conceptualizing skills rather than their concrete experience skills in order to become successful in TIMSS assessments.

With concrete experience (CE) that both divergers and accomodators prefer, learners rely on their feelings in solving a problem, rather than using theories and generalizations (Kolb, 1984; 1999). These strategies used by divergers and accomodators might be inadequate when it comes to solving science problems, thus leading to lower science achievement. As Kolb stated, concrete experiences provide a basis for learning. However, these experiences need to turn into observations, abstract conceptualizations and finally active experimentation for a complete understanding of the topic to be achieved.

When examining the cognitive domain scores separately, there was less differentiation among groups in the knowing domain of the science test, whereas scores varied significantly in the reasoning domain. It seems that the effect of learning styles on science achievement is less pronounced in the knowing domain, whereas it becomes more apparent in the applying and reasoning domains. According to Anderson and Krathwohl (2001), in the knowledge domain, instruction and evaluation are based on recalling information that is independent of the context. In higher order domains, however, recalled information is used in constructing new knowledge or solving new problems. As the results of the current study show, students' learning styles do not matter as much in answering knowledge-domain items compared to applying- and reasoning-domain items.

Learning style preference can be a predictor of an individual's specialization. For instance, assimilators tend to specialize in sciences and information technologies, while convergers are likely to specialize in engineering, medicine and technology (Kolb & Kolb, 2005a). As the findings of this study showed, students might be rewarded in science for prefering assimilating or converging learning styles. However, there might be another explanation for this phenomenon. Cano-García and Hughes (2000) state that the educational system might be favoring specific learning styles. In other words, the reason that assimilators and convergers in this study have been more successful on the science test is that the teachers of the study sample might be using teaching styles that are pertinent to these learning styles. In this case, the higher academic achievement might be due to the match between teachers' teaching styles and the students' learning styles (JilardiDamavandi et al., 2011). However, as in this study, students who prefer diverging and accomodating styles and who are less successful in science make up more than half of the sample. It is possible that the instructional methods used in science classrooms might be inefficient in meeting the needs of such learners. Therefore, it is crucial to assess students' learning styles in order to motivate educators to reflect on their teaching styles (Cano-García & Hughes, 2000).

There is strong empirical evidence from various disciplines that learners' performance has increased when teaching is arranged according to their learning preferences (Dyer & Schumann, 1993; Kolb, 1984; McGlinn, 2003; Sandmire & Boyce, 2004; Stiernborg, Zaldivar & Santiago, 1996). Therefore, teachers need to take into account the diversity of learning styles in their classrooms in order to benefit all students. Kolb and Kolb (2005a) state that knowing individuals' learning styles helps instructors to select the most appropriate learning approaches in different learning contexts. As well as teaching activities, different approaches to assessment are also needed to accommodate diverse learners in the classroom (Stears & Gopal, 2010).

As mentioned earlier, most of the experimental studies dealing with learning styles have been conducted with a higher-education population. Further empirical evidence is needed for whether learning-style-based instruction described by Kolb improves primary-school students' achievements. Since TIMSS assessments target the primary-school population, studies could be designed to investigate the effects of learning-style-based instruction on students' TIMSS science achievement scores or academic achievement scores in general.

Kolb and Kolb (2008) recommend that researchers conduct applications with regard to ELT in order to improve learning and development. As a widely accepted theory around the world, ELT can be used in experimental studies where instruction is designed based on students' learning styles. Specific to science education, teaching/learning activities might be arranged to accommodate concrete learners without jeopardizing the development of abstract learners.

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TIMSS Bilişsel Alanlarındaki Fen Başarısının Öğrenme Stilleri Açısından İncelenmesi

Atıf:

Kablan, Z. & Kaya, S. (2013). Science achievement in TIMSS cognitive domains based on learning styles. *Egitim Arastirmalari-Eurasian Journal of Educational Research,* 53, 97-114.

Özet

Problem Durumu: Uluslararası Matematik ve Fen Eğilimleri Araştırması (TIMSS) gibi karşılaştırma çalışmalarında ulusal düzeyde örneklem olarak belirlenen öğrenci gruplarının fen ve matematik alanlarına yönelik olarak başarı düzeyleri ölçülmektedir. Bu çalışmada yer verilen sorular bilme, uygulama ve akıl yürütme olarak nitelendirilen 3 bilişsel alanda toplanmaktadır. Sözü edilen bu uluslararası karşılaştırma sınavlarında düşük ya da yüksek başarının arkasında yatan unsurları daha iyi anlamak için, bu sınavlardan elde edilen veriler üzerinde çalışmalar yapılmaktadır. Bu araştırmada ise öğrencilerin öğrenme stillerine göre TIMSS sınavındaki fen başarı düzeylerinin belirlenmesi amaçlanmıştır. Öğrenme stillerine yönelik en önemli modellerden biri 1970'li yılların başında David Kolb tarafından öne sürülen Yaşantısal Öğrenme Kuramı olup, bu kuramı test etmek için geliştirilen Öğrenme Stili Envanteri günümüze kadar birçok alanda kullanılmıştır. Kolb'un yaşantısal öğrenme kuramına göre değiştiren, özümseyen, ayrıştıran ve yerleştiren

olmak üzere dört tür öğrenme stili bulunmaktadır. Öğrenme stillerinin ve bunların bilişsel alanlar üzerindeki etkisinin incelenmesi, öğretimin farklılaştırılmasına yönelik eğitimcilere yol gösterip TIMSS başarısının artışına katkı sağlayabilir.

Araştırmanın Amacı: Bu çalışmanın amacı, Kolb'un modelinde yer alan soyut kavramlaştırma gibi öğrenme biçimleri ile TIMSS fen başarısı arasındaki ilişki düzeylerini, ayrıca değiştiren, özümseyen, ayrıştıran ve yerleştiren öğrenme stillerine göre başarının farklılaşıp farklılaşmadığını belirlemektir. Ayrıca araştırmada fen başarısı bilgi, uygulama, akıl yürütme olarak tanımlanan üç bilişsel öğrenme düzeyine göre de analiz edilmiştir.

Araştırmanın Yöntemi: Betimsel türde olan bu araştırmanın katılımcılarını beş farklı okuldan seçilmiş toplam 437 öğrenci oluşturmaktadır. Bu öğrenciler daha önce herhangi bir TIMSS uygulamasına katılmamıştır. Araştırmada öğrenme stilleri Kolb'un Öğrenme Stilleri Ölçeği'ne dayalı olarak, 8. sınıf fen başarısı ise TIMSS sorularından oluşan bir testle ölçülmüştür. Öğrencilerin öğrenme biçimleri ile fen başarısı arasındaki ilişki korelasyon, stillere göre fen başarısı düzeyleri toplam puan olarak analiz edilirken tek faktörlü varyans analizi (ANOVA), diğer taraftan bilgi, uygulama ve akıl yürütme şeklinde tanımlanan üç alt puan türünde analiz edilirken ise çok değişkenli varyans analizi (MANOVA) yöntemi kullanılmıştır.

Araştırmanın Bulguları: Araştırmadan elde edilen sonuçlara göre soyut kavramlaştırma puanları ile fen başarısı arasında pozitif, diğer taraftan somut deneyim ve yansıtıcı gözlem puanları ile fen başarısı arasında ise negatif ilişki belirlenmiştir. Sözü edilen bu ilişki derecelerinin bilişsel alanlar açısından bilgi düzeyinden akıl yürütme düzeyine doğru artma eğilimi gösterdiği söylenebilir. Araştırmada ayrıca özümseyen ve ayrıştıran öğrenme stili baskın olan öğrencilerin TIMSS fen sorularına doğru cevap verme düzeyi açısından her üç bilişsel alanda da daha yüksek başarı gösterdiği belirlenmiştir. Diğer taraftan değiştirme stiline sahip öğrenciler ise gerek toplam fen puanı, gerekse bilişsel öğrenme alt test puanları açısından daha düşük başarı elde etmiştir. Öğrencilerin fen başarısı, bilgi düzeyindeki sorulara göre değerlendirildiğinde öğrenme stilleri arasında farklılaşmanın daha az olduğu, uygulama düzeyinde bu farklılaşmanın arttığı, en belirgin farklılıkların ise akıl yürütme düzeyinde olduğu söylenebilir.

Araştırmanın Sonuçları ve Önerileri: Araştırmada TIMSS sorularına göre hazırlanmış fen testinde ayrıştıran ve özümseyen stiline sahip öğrencilerin yerleştiren ve değiştiren stiline sahip öğrencilere göre daha başarılı olduğu belirlenmiştir. Ayrıştıran ve özümseyen stillerini diğer iki stilden ayıran ve ikisinin ortak özelliği olan unsur; bu stillerdeki öğrencilerin soyut kavramlaştırma puanının somut deneyim puanından daha yüksek olmasıdır. Diğer bir deyişle aktif deneyim ve yansıtıcı düşünme boyutları sabit tutulduğunda ölçeği dolduran öğrencinin somut puanın artması onu yerleştiren-değiştiren stillerine, tersi durumda soyut kavramlaştırma puanının artması ise ayrıştıran ve özümseyen stillerine yaklaştırmaktadır.

Kolb'ın yaşantısal öğrenme kuramında, soyut kavramlaştırma öğrenme yolunu kullanan öğrencilerin somut deneyimlere oranla olayları açıklamak için analitik kuramlara, soyut kavramlara, fikirlere ve problem çözmeye daha fazla odaklanabildiği öne sürülmektedir. Diğer taraftan yerleştiren ve değiştiren stillerinin temel yapısını oluşturan somut deneyimlerle öğrenmede ise, kuram ya da genellemelere ulaşmak yerine anlık deneyimlere dayalı olarak ve konu üzerinde yeterince düşünmeden, durumu hissederek sorunun çözümüne gidilmesi tercih edilmektedir. Yerleştiren ve değiştiren stiline sahip öğrencilerin fen başarılarının daha düşük olması, izlemek, gözlemlemek ya da hissetmek gibi somut yaşantısal yolları daha fazla tercih edip, soyut kavramlaştırmaya yönelik öğrenme yollarına daha az önem vermeleriyle açıklanabilir. Fen başarısına bu açıdan bakıldığında Kolb'un da belirttiği gibi somut öğrenme aşamasının esas öğrenmeler için bir temel olduğu, önemli olanın soyut kavramlaştırma ve en sonunda da aktif deneyime ulaşmak olduğu sonucuna varılabilir.

Özümseyen ve ayrıştıran öğrencilerin özellikle uygulama ve akıl yürütme düzeyindeki soruları çözerken hipotez, analiz ve sentez etme, sonuç çıkarma, genellemeye varma ve değerlendirme gibi farklı problem çözme stratejilerini ve soyut becerileri kullanabilmeleri onların daha yüksek puan almalarına yarar sağlamış olabilir. Ayrıca araştırmada bilgi düzeyindeki sorular açısından öğrenme stilleri arasında farklılığın daha az olması, uygulama ve akıl yürütme sorularında farklılığın daha belirgin olması yukarıda yapılan açıklamayı desteklemektedir. Buna göre bilgi düzeyinde öğrencinin sadece hatırlaması, daha üst düzey öğrenmelerde ise bilgiden anlam çıkarması ve onu kullanabilmesi gerekir. Bu araştırmaya dayalı olarak bilgi düzeyindeki fen sorularını çözerken öğrencinin sahip olduğu stilin, uygulama ve akıl yürütme türündeki soruları çözmesine oranla daha az öneme sahip olduğu söylenebilir.

Öğrenme stilleri ile ilgili olarak geçmişte yapılan araştırmalarda özümseyen stili, bilgi teknolojileri ve fen alanında, ayrıştıran stili ise benzer şekilde teknoloji ve mühendislik gibi alanlarda başarıyı açıklayan önemli bir değişken olarak nitelendirilmektedir. Bu durum öğrencilerin kendi stillerine bağlı olarak belli branşlarda daha başarılı olabileceği gibi bir sonuca bağlanabileceği gibi, bu görüşe alternatifler de sunulabilir. Sözgelimi ayrıştırıcı ve özümseyici öğrencilerin fen testlerinde daha başarılı olmaları, genelde bu öğrencilerin öğretmenlerinin de sözü edilen öğrenme yollarına uygun öğretim stillerini kullanmalarından kaynaklanıyor olabilir. Bu durumda öğretmenler, kendi stillerini öğrencilerin öğrenme stilleri doğrultusunda düzenlemeleri konusunda teşvik edilebilir.

Öğretmenin kendi stilini öğrencilerin öğrenme stillerine göre düzenlemesinin öğrenme etkililiğini artırdığına yönelik birçok araştırma bulgusu bulunmaktadır. Ancak bu tür çalışmaların daha çok yüksek öğretim düzeyinde yapıldığı, ilköğretim düzeyinde yeterli çalışmaya rastlanmadığı söylenebilir. Öğrenme stillerine dayalı olarak düzenlenen öğretim yöntem ve yaklaşımlarının ilköğretim düzeyinde akademik başarıya etkisini belirlemeye yönelik yeni araştırmaların yapılması önerilmektedir.

Anahtar Sözcükler: Kolb'un öğrenme stilleri, TIMSS, fen başarısı, bilişsel alanlar, soyut kavramlaştırma, somut deneyim.