**Australian Journal of Teacher Education**

Volume 39 | Issue 12 Article 5

2014

# Preservice Teachers' Constructivist Teaching Scores Based on Their Learning Styles

Zeynel Kablan
*Kocaeli University*, zeynelkablan@gmail.com

Sibel Kaya
sibelkaya@gmail.com

# Pre-Service Teachers' Constructivist Teaching Scores Based on Their Learning Styles

Zeynel Kablan
Sibel Kaya
Kocaeli University
Turkey

*Abstract:This study examined the relationship between pre-service teachers' constructivist teaching and their learning styles based on Kolb's Experiential Learning Theory. The Learning Styles Inventory-3 was administered at the beginning of the semester to determine preferred learning style. The Constructivist Teaching Evaluation Form was filled out by pre-service teachers following the microteaching session. Bivariate correlation and ANOVA anayses were conducted to evaluate the learning style-teaching relationship. Results showed that students' teaching evaluation scores were positively correlated with their active experimentation (AE) and negatively correlated with their reflective observation (RO) scores. ANOVA results showed that accommodating students had significantly higher self-evaluation scores than diverging and assimilating students. Moreover, converging students rated themselves higher than diverging students on constructivist teaching. These results imply that pre-service teachers who prefer constructivist learning strategies deliver better constructivist lessons based on their self reports.*

**Key words:** Learning styles, constructivist teaching, microteaching, pre-service teachers.

## Introduction

Recent education reform requires teachers to depart from the traditional practice of knowledge transmission to constructivist teaching where students are encouraged to construct knowledge through inquiry (Beck, Czerniak & Lumpe, 2000; Levitt, 2002). Constructivist classrooms allow students to actively participate in the learning activities to construct their knowledge thus, keep them engaged during a longer period of time (Schraw & Lehman, 2001; Schraw, Flowerday & Lehman, 2001). Since knowledge construction requires connection with prior knowledge, constructivist teaching draws on students' prior knowledge and experiences (Driscoll, 2005). Rich and authentic contexts need to be provided for students for them to link school learning with the world outside school (Jonassen, 1999). A teacher's main role in constructivist classrooms is to help students create meaning through active and relevant experiences. In constructivist classrooms students are encouraged to share their ideas unlike traditional classrooms where instruction is mainly based on textbook (Brooks & Brooks, 1999). In general terms, constructivism helps students to discover knowledge through active

participation (Brooks & Brooks, 1999; Schraw & Lehman, 2001; Schraw et al., 2001), peer interaction (Jonassen, 1999), engaging material (Jonassen, 1999), triggering prior knowledge (Driscoll, 2005) and high-level questioning (Erdogan & Campbell, 2008; Graesser & Person, 1994). Teacher education programs should include frequent opportunities of constructivist teaching experiences for pre-service teachers in order for them to gain content and pedagogical skills (Haney & McArthur, 2002).

Despite the reform efforts that advocate student-centered constructivist teaching, teachers still heavily rely on more traditional pedagogies, such as lecturing, drill and practice at all levels of schooling (Berberoglu, 2010: Fischer-Mueller & Zeidler, 2002; Simmons et al., 1999; Uğurel, Bukova-Güzel & Kula, 2010). Some teachers are unable or unwilling to modify their practices that align with recent reform initiatives (Davis, 2003) that encourage active participation of students, inquiry, discovery, and critical thinking (National Academy of Sciences, 2006; National Science Board, 2007). These teachers point out various factors for their inability to change their practice, such as school climate, student response, inadequacy of physical space, instructional materials, and academic time devoted to teaching (Lynch, 2000; Vesilind & Jones, 1998). Though more positive, pre-service teachers too, have difficulty in implementing constructivist teaching strategies. They show reasons such as lack of knowledge, large class sizes and inadequate school facilities for this phenomenon (Uzuntiryaki, Boz, Kirbulut & Bektas, 2010). Bandura (1997) argues that teachers' preference of either traditional or constructivist teaching was affected by several factors such as experiences of university teacher education, past school experiences, out-of-school experiences, and personal beliefs. Levitt (2002) stated teachers may be convinced about the value of student-centred constructivist activities but they may not able to deliver the activities successfully. They tend to rely on textbook where teacher questions mostly focus on factual information (Levitt, 2002; Weiss, Pasley, Smith, Banilower & Heck, 2003).

The current teacher-centered educational practices might be favoring certain learning styles, while they neglect others (Kablan & Kaya, 2013; JilardiDamavandi, Mahyuddin, Elias, Daud & Shabani, 2011). Some researchers argue that traditional methods such as lecturing serves to abstract learning (Jones, Reichard & Mokhtari, 2003; Kolb, 1984; Sharp, Harb & Terry, 1997). According to the Experiential Learning Theory (ELT), Kolb (1984) described different learning styles that describe personal preferences in a learning environment (see Figure 1). In Kolb's ELT there are four modes in an effective learning cycle: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). Kolb stated that an individual's learning style is determined by the combination of the four learning modes that stretch on two dimensions. The first dimension (AC-CE) also known as the abstract-concrete dimension reflects how we perceive and grasp new information. The second dimension (AE-RO), the active-reflective continuum, deals with how we process new information (Kolb, 1984). Individuals with abstract conceptualization and reflective observation as dominant learning modes are called assimilators. They prefer reading, lectures and exploring models in formal learning settings. (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 who utilize abstract conceptualization and active experimentation are called convergers. Convergers prefer experimenting, simulations and laboratory assignments (Kolb & Kolb, 2005a). Learners 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 (Kolb, 1984; Healey & Jenkins, 2000; Jones et al., 2003). 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; Davies, Rutledge & Davies, 1997). 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.

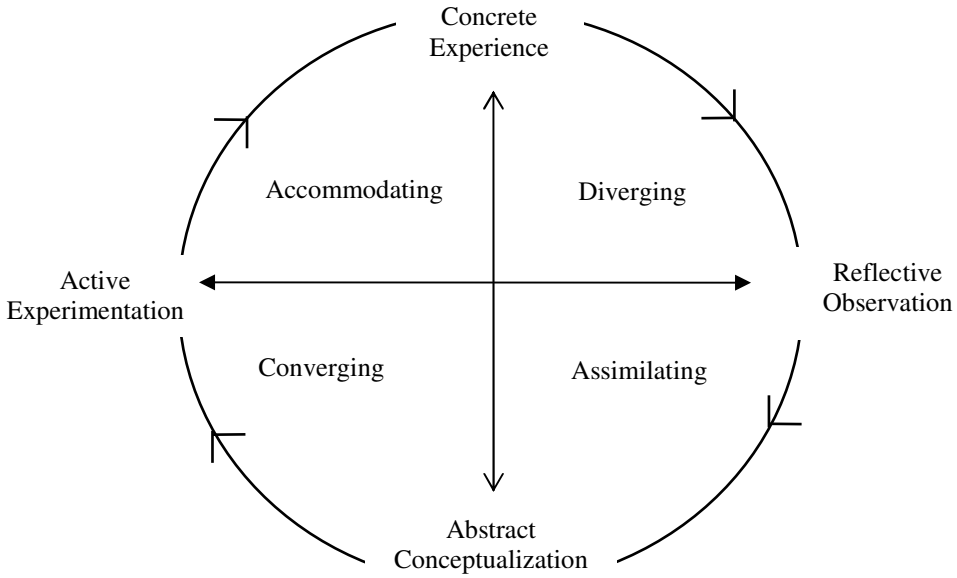


**Figure. 1 Kolb's Learning Styles (Adapted from Kolb, 1984)**

Grasha and Yangarber-Hicks (2000) state that learning styles and teaching styles are mutually dependent, thus they need to be examined together. Students might be adapting their learning styles to their teachers' teaching styles (Cano-García & Hughes, 2000). It is likely that pre-service teachers' learning styles that they developed over the years as students might be affecting their teaching styles. The current study was designed to reveal whether there is relationship between pre-service teachers' learning styles and the way they teach. The impact of learning styles on achievement (Kablan & Kaya, 2013; Boyatzis & Mainemelis, 2000; Jones et al., 2003; JilardiDamavandi et al., 2011; Terrell, 2002) and career choice (Kolb, Boyatzis & Mainemelis, 2000; Kolb & Kolb, 2005a) were frequently investigated. Based on the findings of these studies, it was hypothesized that there would be differences in the way pre-service teachers teach depending on their learning styles. The purpose of this study was to examine the relationship between pre-service teachers' learning styles and their constructivist teaching scores. The results may offer implementations for teacher education programmes regarding the inclusion of learning styles.

## Methods

The current study is a comparative/correlational research that aims to examine the relationships between pre-service teachers' preferred learning style and their constructivist teaching scores. In comparative/correlational studies information is collected without manipulating the environment. These studies are conducted to demonstrate associations between variables. Causality cannot be inferred (Creswell, 2008). The scores on Kolb Learning Styles Inventory results in two different types of variables: one of them is the dimension scores which is a continuous variable. The other one is the learning styles which is a categorical variable. For the continuous variable, bivariate correlation analysis, for the categorical variable Analysis of Variance (ANOVA) was used.

### Participants

The participants of the study were 198 second year students enrolled in the Faculty of Education at a large university in northwestern Turkey. Of the students, 94 were in primary education and 104 were in primary mathematics education program. There were 164 (82.8 %) female and 34 (17.2 %) male participants. Of the participants, 105 (53 %) of them were involved in the study during the first year and 93 (47 %) of them were involved during the second year. Data were collected for two periods in order to increase the sample size.

### Instrument and Procedures

Data was collected between 2012-2014, during the 'Instructional Principles and Methods' course taught at the Faculty of Education. One of the requirements of this course was to teach a 5-10 minutes micro lesson in class. For their micro lesson topic, unlike mathematics education students, primary education students chose their preferred subject, such as science, social studies or mathematics. Introduced in the early 1960s, microteaching has evolved as one of the most widely used methods to introduce clinical practicum experiences to pre-service teachers (Amobi, 2005; Benton-Kupper, 2001). When planning for microteaching, pre-service teachers have opportunities to use variety of strategies they learned in the methods course, thus have a chance to connect theories with practice (Wilkinson, 1996). Through constructive feedback given by peers and the instructor following their microteaching, pre-service teachers are encouraged to develop effective teaching skills and reflect on these emergent skills (Amobi & Irwin, 2009; Ostrosky, Mouzourou, Danner & Zaghlawan, 2013) as well as learn from their mistakes (Miller, 2009). It helps pre-service teachers to perform classroom applications on a smaller scale. Since the pre-service teachers in this study had the independence of chosing their own topic and method to teach, it was assumed that they delivered one of their best performances.

Each pre-service teacher completed a self-evaluation form after the micro-lesson. This was the 'The Constructivist Teaching Evaluation Form' that consisted 12 items regarding the various aspects of constructivist learning. For the development of this instrument, constructivist learning literature was reviewed (Campbell, Abd-Hamid & Chapman, 2010; Morrell, Wainwright & Flick, 2004; Piburn et al., 2000). Items that included activities with student-centred, constructivist focus measured pre-service teachers' constructivist teaching ability.

The items were scored according to a 5-point Likert-like format with 1 being 'very unsuccessful' and 5 being 'very successful'. For further validity of the instrument, two university professors in science education program were consulted.

Exploratory factor analysis yielded 11 items that loaded under the constructivist teaching factor. One item was not included in the analysis due to low factor load. The highest possible score was 55 and the lowest possible score was 11 on the form. Table 1 shows the factor loadings of the 11 items. Accordingly the highest factor load was 0.829 and the lowest factor load was 0.562. The Cronbach alpha reliability coefficient of the 11 items was 0.911.

| Item | Factor Loading |
|---|---|
| 6. I used follow-up questions to elaborate student answers. | 0.829 |
| 4. Instead of providing the answer I encouraged students to find the answer themselves. | 0.820 |
| 11. I asked high-level, critical thinking questions. | 0.816 |
| 8. Rather than transmitting the knowledge, I let students discover during activities. | 0.805 |
| 2. I helped students find the answers through questioning. | 0.784 |
| 1. I encouraged student participation through engaging materials. | 0.761 |
| 7. I provided adequate wait-time after each question to help students elaborate their answers. | 0.735 |
| 10. I encouraged all students to participate in activities. | 0.672 |
| 9. I encouraged peer interaction. | 0.612 |
| 3. I connected students' current knowledge with their prior knowledge. | 0.601 |
| 5. I gave responsibilities to students in order to increase participation. | 0.562 |

**Table 1. Factor Loadings of the Constructivist Teaching Evaluation Items**

The Kolb's Learning Style Inventory (LSI)-Version 3 (Kolb 1999) was used to determine participants' learning styles. This inventory was administered and the participants were informed about their learning styles at the end of the course so that the results would not influence their teaching performance and constructivist teaching scores. 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). Based on their combination scores of AC-CE and AE-RO, students were grouped in four types of learning styles, diverging, assimilating, converging, and accommodating.

#### Data analysis

Statistical analysis was conducted using SPSS 18. Bivariate correlation analysis was conducted in order to examine the relationships among students' self-evaluation scores and Kolb's dimension scores. Differences in evaluation scores of students in four types of Kolb's learning styles were examined through Analysis of Variance (ANOVA).

## Results

Table 2 shows the distribution of pre-service teachers' learning styles and descriptive statistics of constructivist teaching scores. Accordingly, nearly half of the participants (46.46 %) preferred assimilating learning style while the least preferred learning style was diverging (9.10 %). While descriptive statistics of constructivist teaching scores are examined, accommodators had the highest score (Mean=44.07, SD=11.04) while divergers had the lowest score (Mean=36.22, SD=6.80).

| Style | f | % | Mean | SD |
|---|---|---|---|---|
| Diverging | 18 | 9.10 | 36.22 | 6.80 |
| Assimilating | 92 | 46.46 | 38.84 | 8.60 |
| Converging | 58 | 29.29 | 41.86 | 10.28 |
| Accomodating | 30 | 15.16 | 44.07 | 11.04 |

**Table 2. Descriptive Statistics of Constructivist Teaching Scores by Learning Style**

Table 3 shows the bivariate correlation analysis results. Accordingly, students' teaching self-evaluation scores were positively correlated with their active experimentation (AE) ($r=0.202$, $p<0.01$) and negatively correlated with their reflective observation (RO) scores ($r=-0146$, $p<0.05$). There were no correlations with concrete experience (CE) and abstract conceptualization (AC) scores. Furthermore, evaluation scores were positively correlated with AE-RO dimension ($r=0.194$, $p<0.01$).

| | CE | AC | AE | RO | AC-CE | AE-RO |
|---|---|---|---|---|---|---|
| Pearson Coefficient | -0.008 | -0.043 | 0.202** | -0.146* | -0.023 | 0.194** |
| p | 0.911 | 0.545 | 0.004 | 0.040 | 0.749 | 0.006 |

**Table 3. Bivariate Correlations Among Teaching Evaluation Scores and Dimension Scores**
*Correlation is significant at the p<0.05 level, **Correlation is significant at the p<0.01 level

Displayed in Table 4, analysis of variance (ANOVA) results showed that there are statistically significant differences in the teaching evaluation scores among the different learning styles ($F=4.026$, $p<0.01$). For the additional exploration of the differences among means, post-hoc analysis was conducted and it was found that the accommodating students (Mean=44.07, SD=11.04) had significantly higher evaluation scores than diverging (Mean=36.22, SD=6.80) and assimilating (Mean=38.84, SD=8.60) students. Moreover, converging students

(Mean=41.86, SD=10.28) rated themselves higher than diverging students. There were no other differences in scores among learning styles.

| | Sum of Squares | df | Mean Square | F | p | Differences* |
|---|---|---|---|---|---|---|
| Between Groups | 1062.869 | 3 | 354,290 | 4.026 | 0.008 | 3>1, 4>1, 4>2 |
| Within Groups | 17070.811 | 194 | 87,994 | | | |
| Total | 18133.680 | 197 | | | | |

**Table 4. Analysis of Variance (ANOVA) Results of Teaching Evaluation Score by Learning Styles**
*1: Diverging, 2: Assimilating, 3: Converging, 4: Accommodating

## Discussion

This study examined the relationships between pre-service teachers' constructivist teaching scores and their learning styles based on Kolb's Experiential Learning Theory (Kolb, 1984; Kolb & Kolb, 2005a; Kolb & Kolb, 2005b). The first finding was that approximately half of the participants preferred the assimilating learning style. This may be due to the common occurance of traditional teacher-centered approaches used in classrooms in Turkey. Although a constructivist program took effect recently in Turkey, many teachers do not use this approach and they teach to the test (Berberoglu, 2010). As argued by Cano-García and Hughes (2000) teachers' teaching styles might have influenced students' learning styles. Hence, it was hypothesized that there might be a relationship between the pre-service teachers' learning styles and their skills of delivering a constructivist instruction. This was in fact confirmed by the findings. It was found that accommodating students had significantly higher constructivist teaching scores than diverging and assimilating students. Similarly, converging students too, rated themselves higher than diverging students on constructivist teaching. These results imply that pre-service teachers who prefer constructivist learning strategies deliver better constructivist lessons based on their self reports.

The highest constructivist teaching score was that of accommodators who have concrete experience and active experimentation as their dominant learning modes. These learners usually prefer 'hands on' experiences, learning through self-discovery, testing different approaches, and group work (Healey & Jenkins, 2000; Jones et al., 2003; Kolb & Kolb, 2005a). These strategies are consistent with the common features of constructivism and it is likely that the participants reflected their own learning preferences into their teaching. The constructivist teaching evaluation form used in this study was developed based on the major aspects of constructivism pointed out in the literature (Campbell et al., 2010; Morrell et al., 2004; Piburn et al., 2000). These aspects were discovery learning, active participation, peer interaction, engaging materials, using prior knowledge, and high-level questioning. These aspects are closely related to Kolb's active experimentation dimension. In the current study, accommodators and convergers, who prefer active experimentation, had relatively higher constructivist teaching scores compared to divergers and assimilators who prefer more passive, reflective observation. Results showed that students' constructivist teaching self-evaluation scores were positively correlated with their

active experimentation (AE) and negatively correlated with their reflective observation (RO) scores. The (AE-RO) dimension, the active-reflective continuum, deals with how we process new information. Active Experimentation mode describes individuals who take a practical approach and are concerned with what practically works rather than simply observing a situation. These individuals learn by 'doing' and actively participating rather than observing. They do not prefer passive learning situations, such as lectures. Active experimenters are risk takers and they are good at group work (Kolb, 1984; Kolb & Kolb, 2005a).

Active experimenters tend to be more successful when the learning environment was arranged based on their preferences. Tulbure (2011) found that accommodators were more successful when problem solving approach was used. Similarly, convergers were more successful when investigation method was used. Both of these methods are in line with constructivism where learners are active participants. In another study, Gurpinar and colleagues (2010) reported that accommodators were more successful in problem-based learning exams, whereas assimilators were more successful in theoretical block exams. These studies reveal that students who prefer active experimentation are more advantaged in constructivist teaching environments. Pre-service teachers might have adopted these teaching strategies as instructors.

The current study examined the relationship between pre-service teachers' learning styles and their skills of designing a constructivist learning environment through microteaching. The findings were different from those of other studies where observed behaviours were different. For example, in terms of academic achievement, in general, convergers and assimilators were found to be more advantaged (Boyatzis & Mainemelis, 2000; Jones et al., 2003; Terrell, 2002; JilardiDamavandi et al., 2011). Other line of research 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). It can be concluded that the role of learning styles differ based on the skill that is measured.

This study was limited with self-reported data from pre-service teachers. Self-reported data was used in order to reach a large sample size for more generalizable results. Future studies might involve observational data with smaller samples. The study was also limited in terms of cultural context. The results can only be generalized to the Turkish culture. The results might differ in other contexts.

Based on the findings of this study it can be concluded that teachers who prefer active learning methods tend to be better in implementing constructivist teaching methods and they might have adopted those strategies that are more aligned with their own learning style. For the educational implementation of this finding a word of caution is in order. Although constructivism is deemed a reform based teaching method, traditional teacher-centered methods can be as effective as constructivist methods for certain learning styles. For example, in math and science, assimilators who prefer lectures tend to be more successful. Thus, rather than serving only certain types of learners teachers are recommended to adopt flexible teaching styles where methods can be adjusted based on different learning styles and different subjects. Teacher education programmes need to integrate classroom applications of various teaching strategies into their curriculum in order to equip pre-service teachers with flexible teaching styles.

**References**


Amobi, F. A. (2005). Preservice teachers' reflectivity on the sequence and consequences of teaching action in a microteaching experience. *Teacher Education Quarterly, 32*, 115-130.

Amobi, F. A., & Irwin, L. (2009). Implementing on-campus microteaching to elicit preservice teachers' reflection on teaching actions: Fresh perspective on an established practice. *Journal of the Scholarship of Teaching and Learning, 9*, 27-34.

Arslan, B. & Babadoğan, C. (2005). İlköğretim 7. ve 8. sınıf öğrencilerinin öğrenme stillerinin akademik başarı düzeyi, cinsiyet ve yaş ile ilişkisi. *Eğitim Araştırmaları Dergisi, 2*, 35-48.

Arthurs J. B. (2007). A juggling act in the classroom: Managing different learning styles. *Teaching and Learning in Nursing, 2*, 2-7. http://dx.doi.org/10.1016/j.teln.2006.10.002

Bandura, A. (1997). *Self efficacy: The exercise of control*. New York: W.H. Freeman.

Beck, J., Czerniak, C. M., & Lumpe, A. T. (2000). An exploratory study of teachers' belief regarding the implementation of constructivism in their classrooms. *Journal of Science Teacher Education, 11*(4), 323-343. http://dx.doi.org/10.1023/A:1009481115135

Benton-Kupper, J. (2001). The microteaching experience: Student perspectives. *Education, 121*, 830-835.

Berberoglu, G. (2010). Öğrenci başarısının değerlendirilmesi nasıl yapılır? *CITO Eğitim: Kuram ve Uygulama Dergisi*, Temmuz-Eylül, 10-22.

Boyatzis, R. E., & Mainemelis, C. (2000). *An empirical study of pluralism of learning and adaptive styles in a MBA Program.* Department of Organizational Behavior, Case Western Reserve University, Cleveland, OH.

Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding: The case for constructivist classrooms.* Alexandria, VA: ASCD-Association for Supervision and Curriculum Development.

Campbell, T., Abd-Hamid, N. H., & Chapman, H. (2010). Development of instruments to assess teacher and student perceptions of inquiry experiences in science classrooms. *Journal of Science Teacher Education*, *21*(1), 13-30. http://dx.doi.org/10.1007/s10972-009-9151-x

Cano-Garcia, F., & Hughes, E. H. (2000). Learning and thinking styles: An analysis of their interrelationship and influence on academic achievement. *Educational Psychology, 20*(4), 413-430. http://dx.doi.org/10.1080/713663755

Creswell, J. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. New Jersey: Pearson: Merrill Prentice Hall.

Davies, S. M., Rutledge, C. M., & Davies, T. C. (1997). The impact of student learning styles on interviewing skills and academic performance. *Teaching and Learning in Medicine: An International Journal*, *9*(2), 131-135.

Davis, K. S. (2003). "Change is hard": What science teachers are telling us about reform and teacher learning in innovative practices. *Science Education, 87*, 3-30. http://dx.doi.org/10.1002/sce.10037

Driscoll, M. P. (2005). *Psychology of learning for instruction.* Toronto: Allyn and Bacon.

Erdogan, I., & Campbell, T. (2008). Teacher questioning and interaction patterns in classrooms facilitated with differing levels of constructivist teaching practices. *International Journal of Science Education, 30*(14), 1-24. http://dx.doi.org/10.1080/09500690701587028

Fischer-Mueller, J., & Zeidler, D. L. (2002). A case study of teacher beliefs in contemporary

science education goals and classroom practices. *Science Educator, 11*(1), 46-57.
Gencel, İ. E. (2006). *Öğrenme stilleri, deneyimsel öğrenme kuramına dayalı eğitim, tutum ve sosyal bilgiler program hedeflerine erişi düzeyi*. [Learning styles, instruction based on Kolb's experiential learning theory, attitude and social studies achievement]. Unpublished doctoral dissertation, Dokuz Eylül Üniversitesi, Eğitim Bilimleri Enstitüsü, İzmir.
Graesser, A. C., & Person, N. (1994). Question asking during tutoring. *American Educational Research Journal, 31,* 104-107. http://dx.doi.org/10.3102/00028312031001104
Grasha, A. F., & Yangarber-Hicks, N. (2000). Integrating teaching styles and learning styles with instructional technology. *College Teaching, 48*(1), 2-10. http://dx.doi.org/10.1080/87567550009596080
Gurpinar, E., Alimoglu, M. K., Mamakli, S. & Aktekin, M. (2010). Can learning style predict student satisfaction with different instruction methods and academic achievement in medical education? *Advances in Physiology Education, 34*, 192-196. http://dx.doi.org/10.1152/advan.00075.2010
Haney, J., & McArthur, J. (2002). Four case studies of prospective science teachers' beliefs concerning constructivist practices. Science Education, 86, 783-802. http://dx.doi.org/10.1002/sce.10038
Healey, M. & Jenkins, A. (2000). Learning cycles and learning styles: The application of Kolb's experiential learning model in higher education. *Journal of Geography*, 99, 185-195. http://dx.doi.org/10.1080/00221340008978967
JilardiDamavandi, A., Mahyuddin, R., Elias, H., Daud, S. M., & Shabani, J. (2011). Academic achievement of students with different learning styles. *International Journal of Psychological Studies, 3*(2), 186-192. http://dx.doi.org/10.5539/ijps.v3n2p186
Jonassen, D. H. (1999). Designing constructivist learning environments. *Instructional Design Theories and Models: A New Paradigm of Instructional Theory*, *2*, 215-239.
Jones, C., Reichard, C., & Mokhtari, K. (2003). Are students learning styles discipline specific? *Community College Journal of Research and Practice, 27*(5), 363-375. http://dx.doi.org/10.1080/713838162
Kablan, Z. & Kaya, S. (2013). Science achievement in TIMSS cognitive domains based on learning styles. *Eurasian Journal of Educational Research,* 53, 97-114. http://dx.doi.org/10.14689/ejer.2013.53.6
Kolb, D. A. (1984). *Experiential learning: Experiencies as the source of learning and development.* Englewood Cliffs, N.J.: Prentice-Hall.
Kolb, D. A. (1999). *The Kolb Learning Style Inventory. Version 3.* Boston: Hay Group.
Kolb, D. A., Boyatzis, R. E. & Mainemelis, C. (2000). Experiential learning theory: Previous research and new directions. In R. J. Sternberg & L. F. Zhang (Eds). *Perspectives on cognitive, learning and thinking styles*. Mahwah, NJ: Lawrence Erlbaum.
Kolb, A. Y., & Kolb, D. A. (2005a). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning & Education*, *4*(2), 193-212. http://dx.doi.org/10.5465/AMLE.2005.17268566
Kolb, A. Y., & Kolb, D. A. (2005b). *The Kolb Learning Style Inventory - Version 3.1, technical specification*. Boston: Hay Group.
Kurbal, S. S. (2011). An investigatıon of mathematics achievement of eighth grade students with respect to their learning styles. Unpublished master's thesis, The Middle East Technical University: Ankara.

Levitt, K. E. (2002). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. Science Education, 86, 1-22. http://dx.doi.org/10.1002/sce.1042

Lynch, S. (2000). *Equity and science education reform*. Mahwah, NJ: Lawrence Erlbaum and Associates

Miller, J. M. (2009). Talking about our troubles: Using video-based dialogue to build preservice teachers' professional knowledge. *Teacher Educator, 44*, 143-163. http://dx.doi.org/10.1080/08878730902954167

Morrell, P. D., Wainwright, C., & Flick, L. (2004). Reform teaching strategies used by student teachers. *School Science and Mathematics*, *104*(5), 199-213. http://dx.doi.org/10.1111/j.1949-8594.2004.tb18243.x

National Academy of Sciences (2006). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington DC: National Academy of Sciences, National Academy of Engineering and Institute of Medicine.

National Science Board (2007). A National action plan for addressing the critical need of the U.S. science, technology, engineering, and mathematics education system. Retrieved October 31, 2014 from http://www.nsf.gov/nsb/documents/2007/stem_action.pdf

Newland, J. R., & Woelfl, N. N., (1992). Learning style inventory and academic performance of students in general pathology. *Bulletin of Pathology Education, 17*, 77-81.

Ostrosky, M. M., Mouzourou, C., Danner, N., & Zaghlawan, H. Y. (2013). Improving teacher practices using microteaching: Planful video recording and constructive feedback. *Young Exceptional Children, 16*(1), 16-29.

Piburn, M., Sawada, D., Turley, J., Falconer, K., Benford, R., Bloom, I., & Judson, E. (2000). *Reformed teaching observation protocol (RTOP) reference manual.* Tempe, Arizona: Arizona Collaborative for Excellence in the Preparation of Teachers.

Schraw, G., Flowerday, T., & Lehman, S. (2001). Increasing situational interest in the classroom. *Educational Psychology Review, 13*(3), 211-224. http://dx.doi.org/10.1023/A:1016619705184

Schraw, G., & Lehman, S. (2001). Situational interest: a review of the literature and directions for future research. *Educational Psychology Review, 13*(1), 23-52. http://dx.doi.org/10.1023/A:1009004801455

Sharp, J. E., Harb, J. N. & Terry, R. E. (1997). Combining Kolb learning styles and writing to learn in engineering classes. *Journal of Engineering Education*, *86,* 93-101. http://dx.doi.org/10.1002/j.2168-9830.1997.tb00271.x

Simmons, P., Emory, A., Carter, T., Coker, T., Finnegan, B., Crockett, D., et al. (1999). Beginning teachers: Beliefs and classroom actions. *Journal of Research in Science Teaching, 36,* 930-954. http://dx.doi.org/10.1002/(SICI)1098-2736(199910)36:8<930::AID-TEA3>3.0.CO;2-N

Terrell, S. R. (2002). The effect of learning style on doctoral course completion in a Web-based learning environment. *Internet and Higher Education, 5*, 345-352. http://dx.doi.org/10.1016/S1096-7516(02)00128-8

Tulbure, C. (2011). Do different learning styles require differentiated teaching strategies? *Procedia: Social and Behavioral Sciences, 11,* 155-159.

Uğurel, I., Bukova-Güzel, E., & Kula, S. (2010). Matematik öğretmenlerinin öğrenme etkinlikleri hakkındaki görüş ve deneyimleri. *Buca Eğitim Fakültesi Dergisi*, 28, 103-123.

Uzuntiryaki, E., Boz, Y., Kirbulut, D., & Bektas, O. (2010). Do preservice chemistry teachers reflect their beliefs about constructivism in their teaching practices? *Research in Science Education, 40*, 403-424.

Vesilind, E. M., & Jones, M. G. (1998). Gardens or graveyards: Science education reform and school culture. *Journal of Research in Science Teaching, 35*(7), 757-775.

Weiss, I. R., Pasley, J. D., Smith, P. S., Banilower, E. R., & Heck, D. J. (2003). *Looking inside the classroom.* Chapel Hill, NC: Horizon Research Inc.

Wilkinson, G. A. (1996). Enhancing microteaching through additional feedback from preservice administrators. *Teaching and Teacher Education, 12*, 211-221.