# Use of the Learning Cycle Model in the Teaching of Chemical Bonding and an Investigation of Diverse Variables in Prediction of Achievement

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## Abstract

*This study aims to determine the effects of the learning cycle model on the levels of prospective teachers' views of the constructivist approach and self-efficacy beliefs in this approach, and whether or not these views of the constructivist approach and self-efficacy beliefs in this approach significantly predict their achievement. The Opinion Scale of Constructivist Approach for Science Teachers, the Self-efficacy Scale for Implementing the Constructivist Approach, and the Chemical Bonding Achievement Test were used as the tools for data collection. The study findings indicated that prospective teachers' views of the constructivist approach and their self-efficacy beliefs in this approach were generally at high levels. It was found that a learning cycle model significantly increased the level of their views of the approach and self-efficacy beliefs in this approach. It was also concluded that the variable of view of the constructivist approach was a significant predictor of their achievement, but that the variable self-efficacy belief was not a predictor of achievement.*

**Keywords:** Achievement, constructivist approach, learning cycle model, self-efficacy belief, view

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## *1. Introduction*

New ideas about learning have been propounded in our world in which knowledge increases and is renewed, and attempts have been made to apply these various learning-teaching theories and strategies formed by these ideas (Hamzadayı, 2010). It was understood that individuals in the 21st century should no longer be educated using approaches towards teaching that place the learner in the position of being a passive receiver (Arslan, 2007). Several studies (Aikenhead, 2005; Balcı, 2007; Lavonen & Laaksonen, 2009; Lunsford, Melear, Roth, Pekins & Hickok, 2007; Roberts, 2007; Roth et al., 2006; Varelas, Pappas & Rife, 2006; Zuzovsky & Tamir, 1999; as cited in Büyüktaskapu, Çeliköz & Akman, 2012, pp. 277-278) revealed that existing teaching programmes are inadequate to provide individuals with the necessary skills to keep up with a developing and changing world. These facts led to changes in the curricula of several different countries (Hand & Treagust, 1991; Osborne & Wittrock, 1983). In the education systems of many countries, such as the United States, Canada, England, Spain, Finland, Ireland, Singapore, a constructivist approach was considered (Acat, Anılan & Anagün, 2007).

"The constructivist perspective of learning has dominated research in science education over the past three decades" (Rahayu, Chandrasegaran, Treagust, Kita & Ibnu, 2011, p. 1441). However, constructivism as a learning philosophy dates back to the studies performed by the 18th-century philosopher Vico. In 1710 Vico stated that "the one who knows a thing is the one who can explain it". Later, Kant developed the idea and stated that "people are not passive in their understanding of knowledge" (Özden, 2011, pp. 56-57). Over time the views of a number of thinkers and scientists were influential in the development and shaping of the constructivist theory. These thinkers and scientists included John Dewey, Jean Piaget, Lev S. Vygotsky, Jerome Bruner and E. Von Glasersfeld (Akinoglu, 2011). "Constructivism is not really a theory about teaching, but rather, it is a theory about knowledge and learning" (Haney & McArthur, 2002, p. 783). Dhindsa and Shahrizal-Emran, (2011) stated that: "Constructivist teaching involved linking new knowledge to students' prior knowledge through their active participation in large and small group discussion to minimize differences in their cognition" (p. 396).

Unlike traditional theories of knowledge, knowledge in constructivism is derived from the learner's existing value judgement and experiences (Akınoglu, 2011). Each individual makes sense according to the meanings and mental structures pre-existing in that person. When newly encountered knowledge or new situations do not comply with pre-existing meanings and mental structures, either modifications are made to the existing structure, or a new structure is formed (Senemoğlu, 2011). Therefore, "constructivist pedagogy in science education invariably starts from an exploration of students' current thinking ..." (Taber, 2010, p. 30).

One of the teaching models that may be included within the application of the constructivist approach is the learning cycle model. The model was developed using Piaget's Theory of Mental Development (Bybee, 1997) as its basis. The learning cycle model helps students to grasp a topic and enables them to understand it on their own and to comment on it (Dikici, Türker & Özdemir, 2010). The model "purposefully promotes experiential learning by motivating and interesting students, as they are encouraged to engage in higher-order thinking ..." (Boddy, Watson & Aubusson, 2003, p. 29). It is a model that is effective for the formation of concepts and concept

systems by students (Lawson, 2001), and it is composed of three stages: research, description of the concepts, and application of the concepts (Nuhoğlu & Yal n, 2006). This three-stage model was later extended into a learning cycle containing five stages. The extended model comprises of: engagement, exploration, explanation, elaboration, and evaluation (Bybee et al., 2006).

Concepts such as adopting a model, self-regulation, self-judgement, and self-efficacy – which were introduced into education by social cognitive theory – occupy an important place in the approaches on which constructivism is based (Turan & Sayek, 2006). Bandura (1986) defined self-efficacy as:

> People's judgment of their capabilities to organize and execute the course of action required to attain designated types of performances. It is concerned not with the skills one has, but with the judgments of what one can do with whatever skills one possesses. (p. 391)

Since the constructivist approach is based on learning on one's own, self-efficacy beliefs affect the individual's efforts to achieve knowledge, and motivation and cognitive awareness skill. In order that individuals can produce knowledge, be active in the learning process, and solve problems, they should use their abilities and capacities to do so; and individuals' level of self-efficacy is important in this process (Çetin, 2009) because individuals with a high level of self-efficacy keep calm when faced with a difficult task while those with a low level of self-efficacy may perceive the task as more difficult than it is, which increases anxiety and restricts perspectives on finding solutions to the problem (Pajares, 1997).

### 1.1. The importance of the study

In the constructivist approach to learning, teachers abandon their traditional roles and take on different ones and adopt a new mental outlook; thus, they play an important part in this process. Therefore, their views and behaviours concerning the difficulty of creating learning environments based on the constructivist approach are important (Rosenfeld & Rosenfeld, 2006). It is considered that determining the views and attitudes of prospective teachers towards applying the constructivist approach in their professional life should provide researchers with information related to the application of the constructivist approach in their classes (İnel, Türkmen & Evrekli, 2010). According to the United States National Science Education Standards, prospective teachers' experiences of a constructivist approach in the process of their professional development may help develop their ability to apply similar experiences in their own classrooms (National Research Council, 1996). In their research, Plourde and Alawiye (2003) found positive and high correlations between prospective teachers' beliefs in constructivism and their abilities to employ the approach in learning environments. Besides this, Uzuntiryaki, Boz, Kirbulut and Bektas, (2010) stated that:

> Pre-service teachers come to university with some beliefs about teaching and learning already developed in earlier years of their education. Since these beliefs influence their practice, identifying pre-service teachers' belief structures early on gains importance. In addition, pre-service teachers should be encouraged to be aware of their beliefs about constructivist teaching practices. We, as teacher educators, cannot understand whether pre-service teachers are ready to implement constructivist teaching strategies without understanding their beliefs. (p. 421)

To sum up, determining prospective teachers' views of, and self-efficacy beliefs in the constructivist approach is important in that it can provide information about whether they are able to implement the approach in their classes when they start their professional life; it might also help them become prepared before starting their teaching careers for probable negative views and beliefs as well as any inherent inadequacies. In the study, Settlage (2000) investigated prospective teachers' confidence toward using the learning cycle approach and found that their self-efficacy toward using the learning cycle increased. Uzuntiryaki et al. (2010) examined prospective teachers' levels of belief in the constructivist approach. Also several studies analysed prospective teachers' views of, and self-efficacy beliefs in, this approach in terms of differing variables (Balım, Kesercioğlu, İnel & Evrekli, 2009; Evrekli, Şaşmaz Ören & İnel, 2010a; 2010b; İnel, Türkmen & Evrekli, 2010; Kesercioğlu, Schallies, Balım, İnel & Evrekli, 2008). Oh and Yager (2004) examined the relations between the development of constructivist science classrooms and changes in student attitudes over time. The other studies in which the applications of constructivist approaches take place analysed the effects of these applications on students' and prospective teachers' achievement in various topics in chemistry (Ağgül Yal n & Bayrakçeken, 2010; Akar, 2005; Çalık, Ayas, Coll, Ünal & Coştu, 2007; Ceylan & Geban, 2009; Vermont, 1984) and their understanding of science concepts (Schneider & Renner, 1980). However, there are no studies in which the applications of constructivist approaches provide the improvement of prospective teachers' views of, and self-efficacy beliefs in this approach. To compensate for this deficiency, it was decided in this study to apply the learning cycle model based on the constructivist approach and to analyse the relevant variables.

### 1.2. The purpose of the study

This study aims to determine the effects of the learning cycle model on the levels of prospective teachers' views of the constructivist approach and self-efficacy beliefs in this approach, and whether or not these views of the constructivist approach and self-efficacy beliefs in this approach significantly predict their achievement.

Thus, answers are sought to the following questions:

1) What are the levels of prospective teachers' views of the constructivist approach?
2) What are the levels of prospective teachers' self-efficacy beliefs in the constructivist approach?
    a) What are the levels of prospective teachers' self-efficacy beliefs in planning lessons based on the constructivist approach?
    b) What are the levels of prospective teachers' self-efficacy beliefs in the learning–teaching process based on the constructivist approach?
    c) What are the levels of prospective teachers' self-efficacy beliefs in developing a learning environment based on the constructivist approach?
    d) What are the levels of prospective teachers' self-efficacy beliefs in the assessment and evaluation process based on the constructivist approach?
3) Is there a significant difference between the pretest–post-test scores for the Opinion Scale of Constructivist Approach for Science Teachers (OSCA)?

4) Is there a significant difference between the pretest–post-test scores for the Self-efficacy Scale for Implementing the Constructivist Approach (SSICA)?
5) Are prospective teachers' views of, and self-efficacy beliefs in, the constructivist approach significant predictors of their achievement?

## *2. Method*

This research employs single group, pretest–post-test design.

### 2.1. Study group

The sample for the study consisted of 32 prospective teachers from the Department of Chemistry Education, Hacettepe University, Turkey who participated in the autumn term of the 2012–2013 academic year. They were second year students at the Hacettepe University. They were chosen from 42 prospective teachers taking the course of Inorganic Chemistry. They voluntarily consented to the study. Of the prospective teachers, 21 were female and 11were male. Their average age was 21. They have scientific background from General Chemistry Course for first year students.

### 2.2. Data collection tools

#### *2.2.1. Opinion scale of constructivist approach for science teachers (OSCA)*

The scale, which was developed by Balım, Kesercioğlu, Evrekli and İnel (2009), is a 5-point Likert-type scale of 30 items, of which 5 are negative and 25 are positive. The researchers found that the scale was composed of a single factor that accounted for approximately 51.18% of the overall variance. The factor loads of the items on the scale ranged between .588 and .808. The Cronbach's alpha reliability coefficient for the scale was .97, and half-test reliability was .93.

#### *2.2.2. Self-efficacy scale for implementing the constructivist approach (SSICA)*

This scale, developed by Evrekli et al. (2010a), is a 5-point Likert-type scale which has 41 items and is composed of four factors. The factors are about planning the lesson (8 items), the learning-teaching process (10 items), developing a learning environment (12 items) and the assessment and evaluation process (11 items). The variance value explained by the scale according to the results of exploratory factor analysis is 13.97% for the first factor, 13.74% for the second factor, 12.88% for the third factor, and 10.33% for the fourth factor. The reliability values for the sub-dimensions of the scale were found to be .84, .88, and .89, respectively. The variance explained by the overall scale was 50.92%, and the Cronbach's alpha reliability coefficient was .96.

#### *2.2.3.Chemical bonding achievement test (CBAT)*

This is a 15-question multiple-choice test prepared by Yılmaz and Dinçol Özgür (2012). In this two-stage test, prospective teachers are asked to answer the questions at the first stage; and then, at the second stage, they are required to mark the reason for the answers they have chosen. This test was used to determine their level of knowledge of the general properties of chemical bonding, electronegativity, types of bonds, bond angles, dual and triple bonds, hybridization, polar and nonpolar molecules, Lewis structure, and intermolecular bonds. It has been analysed by experts in chemistry education, and content validity has been established according to the suggestions of Fraenkel and Wallen (2006). "Content validity refers to judgments on the content and logical

structure of an instrument as it is to be used in a particular study" (Fraenkel & Wallen, 2006, p. 165). The Cronbach's alpha reliability coefficient for the test was calculated as .85.

### 2.3. Application stages of the study

This study was conducted in the context of the Inorganic Chemistry course. This course is allocated a total of four hours per week. One course hour lasts 45 minutes. The study was performed over a five-week period. The topic of chemical bonding, one of the issues in which concept errors are frequently found (Coll & Treagust, 2002; Harrison & Treagust, 2000) was chosen for the research. All researchers contributed to the application process.

- In the first week of the study, 42 prospective teachers taking the course of Inorganic Chemistry were given information about the study by the researchers. The researchers informed the prospective teachers of the importance of and justification for the study. They explained the aim of the study. The prospective teachers were offered general knowledge on the application stages of the study and so were given information about the constructivist approach and learning cycle model. How long the study process would take was explained. Which data collection tools would be administered in the context of the study was also mentioned. The researchers stated that data gathered from the data collection tools would enable them to have information about their views, opinions, beliefs, thoughts and knowledge. The prospective teachers were told that taking part in this study was voluntary and they had the right to withdraw from the research at any time. They were informed that their identities would be protected by using pseudonyms and their information would be kept confidential. After this information process, 32 prospective teachers volunteered to participate in the study. They signed a consent form (URL-1). After that, the OSCA and SSICA were administered to prospective teachers as the pretest treatments. The administration of the scales lasted for 45 minutes. Pretest treatments were administered in the class environment. The other 10 prospective teachers opted out of participating in the study and pretest and post-test treatments but they took part in the teaching of chemical bonding in the context of the Inorganic Chemistry course.
- In the second week of the study, the teaching of chemical bonding through the learning cycle model was started by the first researcher. The model was applied in 5 stages, as set out below.

#### *2.3.1. Engagement:*

At this stage, the prospective teachers were asked various questions so as to focus their attention on the topic and to experience doubt. Some examples of the questions are as follows:

- Diamond is not a conductor of electricity while graphite is. What is the reason for this difference between these two substances, both of which are composed of carbon atoms?
- Although water has the same structure as hydrogen sulphide, it boils at a higher temperature than hydrogen sulphide. What could be the reason for this? (Varol & Gürocak, 2002).

While asking questions, the third researcher wrote out the prospective teachers' responses. By writing the responses, bias was minimized. Through the questions asked, it was tried to make clear to them what knowledge they needed. Starting out from these questions, the prospective teachers stated that the concepts they needed to understand were "ionic, covalent, polar, nonpolar covalent bonds, hydrogen bonds, dipole moment, inert gas structure, allotrope, electronegativity, and stability". Then the prospective teachers were asked to find answers to these questions from available data sources such as textbooks, websites. At the end of this stage, all the researchers got together to assess and document the prospective teachers' preconceptions related to the topic.

***2.3.2. Exploration:***

In the third week of the study, the prospective teachers began to use the questioning method. They first watched a demonstration experiment about ionic and covalent bonds (URL-2). The first researcher asked them inquiry-oriented questions in order to encourage them to form opinions about what activities were undertaken in the experiment. They were given time to give their opinions and thoughts. They were also asked to write down the equations for the actions occurring in the experiment and the atoms' electron sequences, determine the number of valence electrons and the types of electrons coming together in order to form bonds, and to determine how and why bonds are formed by using their prior knowledge. Later, they watched a video about the topic (URL-3). The volume of the video was turned down and they were asked to give their opinions about what was happening, occasionally pausing the video. They were encouraged to brainstorm about the formation of the polar and nonpolar bonds, and give their views about how the molecules become polar and nonpolar. Lastly, they were asked to watch a video about the attraction force between molecules (URL-4). Again, by occasionally pausing the video their knowledge of the attraction force between molecules was tested.

At this stage, they were given an opportunity for discussion and to share their views. Their discussion was recorded by the third researcher, and through this recording the level of their prior knowledge was determined. Additionally, through the discussion they were required to form opinions about the knowledge they and their classmates had concerning the topic. During this process, the researcher attempted to lead the prospective teachers to the topics that they needed to discover. At the end of this stage, all the researchers got together. The researchers examined the discussion records of the prospective teachers. They prepared a lesson presentation by considering both their prior knowledge and lack of knowledge.

***2.3.3. Explanation:***

In the fourth week of the study, the prospective teachers began to put forward their knowledge by using the experience that they had acquired during the exploration stage; thus, they explained their ideas about the topic to their classmates. Having heard the prospective teachers' ideas, the first researcher began to present knowledge on the topic. Their lack of knowledge, especially of electronegativity, electron affinity, polar and nonpolar molecules, intermolecular attraction force, and dipole moment, was taken into consideration. Thus, the knowledge was presented through PowerPoint presentations on chemical bonding, intermolecular interactions, polar and nonpolar

molecules, hybridization, dual and triple bonds, Lewis's theory, electronegativity, electron affinity, dipole moment, solids with ionic and covalent bonds. Videos and animations were used in the presentation of the topic. For reinforcement, of the prospective teachers' were asked questions during the presentation. At the end of this stage, they were asked to research the relationship of the topics to daily life and they were assigned to prepare homework.

***2.3.4. Elaboration:***

In the fifth week of the study, the prospective teachers started to reinforce their knowledge. They were encouraged to associate the concepts learnt with real life. They were also asked to give relevant examples. The homework done by them was collected. Finally, the connection of the topic with real life was summarized. This stage lasted for two course hours.

***2.3.5. Evaluation:***

Evaluation took place throughout the application stage of the study. Also, in the fifth week of the study, the OSCA and the SSICA were administered as post-test treatments. The administration of post-tests lasted for 45 minutes. Also, the CBAT was administered to determine the prospective teachers' achievement related to the topic. The administration of CBAT lasted for 45 minutes. Post-test treatments and CBAT were administered in the class environment.

**2.4. Data analysis**

Before the data analysis, the researchers tried to avoid falsifying and misrepresenting the data. They tried to avoid bias in the data analysis and data interpretation. The researchers tried to be objective in sharing the findings. Results of the study were objectively interpreted and discussed by the researchers.

Descriptive statistics, the paired sample t-test, and multiple linear regression were utilized in the analysis of the data. As in the study performed by Kasapoğlu and Duban (2012), in analysing the data concerning all of the scales and each dimension of the scales, average weight values were calculated (5–1 = 4, 4:5 = 0.8). Based on the values obtained, scores in the 5.00–4.21 range were interpreted as *I definitely/completely agree*, 4.20–3.41 as *I agree*, 3.40–2.61 as *I cannot decide*, 2.60–1.81 as *I disagree*, and 1.80–1.00 as *I definitely/completely disagree*. The CBAT was evaluated by assigning one point for the correct answers given at both stages, and no points for correct answers given only at one stage or for completely incorrect answers. To determine the prospective teachers' achievement scores, product (achievement test and homework) and process evaluation were undertaken, and the scores obtained in the evaluation were used as the achievement scores.

***3. Findings***

In relation to the first question of the study, in considering the OSCA pretest ( $\overline{X}$ = 3.93, sd= 0.48) and post-test ( $\overline{X}$ = 4.35, sd = 0.55) means, it may be said that prospective teachers' views of the constructivist approach were generally at a high level.

With regard to the second question of the study, the prospective teachers' levels of self-efficacy beliefs in the constructivist approach were determined by taking the overall scale and its sub-dimensions into consideration. The results are shown in Table 1.

Insert Table 1 here

It is clear from Table 1 that, in considering the prospective teachers' SSICA pretest ( $\overline{X}$ = 3.83, sd = 0.51) and post-test ( $\overline{X}$ = 4.15, sd = 0.63) means, their self-efficacy beliefs in the constructivist approach can generally be said to be at a high level. By considering the sub-dimensions of the scale, their self-efficacy beliefs in lesson planning (pretest $\overline{X}$ =3.63, sd = 0.65; post-test $\overline{X}$ =4.09, sd =0.65) , the learning-teaching process (pretest $\overline{X}$ = 3.89, sd = 0.49; post-test $\overline{X}$ = 4.16, sd = 0.62), forming learning environments (pretest $\overline{X}$ = 3.88, sd = 0.58; post-test $\overline{X}$ = 4.15, sd = 0.64), and the measurement and evaluation process (pretest $\overline{X}$ = 3.85, sd = 0.58; post-test $\overline{X}$ = 4.17, sd = 0.68) may be said to be at a high level.

In relation to the third and fourth questions of the study, paired sample t-tests were conducted. The results are shown in Table 2.

Insert Table 2 here

A close examination of Table 2 makes it clear that the learning cycle model leads to a statistically significant increase in the prospective teachers' levels of views of the constructivist approach ($t_{(31)} = -3.413$, $p < .05$) and in their levels of self-efficacy beliefs in the approach ($t_{(31)} = -3.019$, $p < .05$).

With regard to the fifth question of the study, multiple linear regression analysis was performed. The results are shown in Table 3.

Insert Table 3 here

It is clear from Table 3 that an examination of the zero-order and partial relations between the predictor variables (view of the constructivist approach and self-efficacy belief for implementing the constructivist approach) and the dependent variable (achievement) shows that a positive and moderate level of relationship exists between the view of the constructivist approach and achievement (r = .63), but that the correlation is r = .56 when the other variable is controlled. On the other hand, the positive, moderate level of correlation between the self-efficacy belief for implementing the constructivist approach and achievement (r = .35) is found to be at a low level (r = .03) when the other variable is controlled.

Predictor variables together have significant and moderate levels of correlation with the achievement variable ($R = .635$, $R^2 = .403$, $p < .05$); these two variables together account for 40% of the total variance in prospective teachers' achievement.

According to the standardized regression coefficient (β), the relative order of importance of the predictor variables on achievement is the view of the constructivist approach and the self-efficacy belief for implementing the constructivist approach, respectively. Examining the t-test results for the significance of the regression coefficients together, it was found that the variable of the view of the constructivist approach was a significant predictor of their achievement, but that the variable of self-efficacy belief was not a predictor of achievement.

### *4. Discussion*

In relation to the first question of the study, by examining the means and standard deviations for the OSCA pretest–post-test results, it might be said that prospective teachers' views of the constructivist approach are high. This result is consistent with several studies (Balım, Kesercioğlu, İnel & Evrekli, 2009; Kesercioğlu et al., 2008). In relation to the second question of the study, the means and standard deviations for the SSICA pretest–post-test results were calculated. The values found were analysed for the overall scale and for the sub-dimensions of the scale. Consequently, prospective teachers' self-efficacy beliefs in the constructivist approach may generally be said to be at a high level, both for the overall scale and for the sub-dimensions of the scale. This result is consistent with the other studies (Demir, Önen & Şahin, 2012; Evrekli et al., 2010a, 2010b; Kasapoğlu & Duban, 2012). The results of the paired sample t-test, which was done in relation to the third and fourth questions of the research, found that the learning cycle model raised the prospective teachers' levels of views of and self-efficacy beliefs in the constructivist approach in a way which was statistically significant. For the fifth question of the study, multiple linear regression analysis was undertaken; it was found that the views of the constructivist approach and self-efficacy beliefs in the approach together yielded a moderately significant correlation with the achievement variable. It was also found that both variables together accounted for 40% of the total variance in achievement. An examination of the results of the t-test, which was undertaken to assess the significance of regression coefficients, showed that the variable of views of the constructivist approach was a significant predictor of achievement, but that the variable of self-efficacy belief in the constructivist approach did not have a significant effect on achievement.

### *5. Conclusions*

In our study, it was found that the learning cycle model, which is based on the constructivist approach, caused a significant improvement in prospective teachers' views of and self-efficacy beliefs in the approach. According to Bandura (2004), because experience is the most important of the four main sources necessary for the development of self-efficacy belief, an experience based on the constructivist approach might, for prospective teachers', result in an increase in their levels of views of and self-efficacy beliefs in the approach. On the other hand, it was also found that their self-efficacy beliefs alone were not a significant predictor of achievement. However, self-efficacy is a significant predictor of achievement Bandura (1977). Although prospective teachers' self-efficacy beliefs were at a high level before and after the application of the learning cycle model, this result may be interpreted as their self-confidence being more than the actual ability.

The positive views the prospective teachers had about the approach were a pleasing result. However, the fact that the self-efficacy variable was not a predictor of achievement on its own shows the need for prospective teachers to have experience of the constructivist approach. A model should be provided to the prospective teachers to apply constructivist approach. Prospective teachers should be provided with the experiences to engage in discussions, to tell and explain their ideas, to thinking. They should be encouraged to be active during the learning process. Prospective teachers that are given opportunities to experience the approach during their education may come to prefer using this approach in their classes when they start their professional life.

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**Table 1: The means and standard deviations for the SSICA pretest–post-test results**

| Self-efficacy belief for implementing the constructivist approach | | SSICA Pretest | | SSICA Post-test | |
|---|---|---|---|---|---|
| | | $\overline{X}$ | sd | $\overline{X}$ | sd |
| Total | | 3.83 | 0.51 | 4.15 | 0.63 |
| Sub-dimensions | Their self-efficacy belief in lesson planning | 3.63 | 0.65 | 4.09 | 0.65 |
| | Their self-efficacy belief in the learning-teaching process | 3.89 | 0.49 | 4.16 | 0.62 |
| | Their self-efficacy belief in forming learning environments | 3.88 | 0.58 | 4.15 | 0.64 |
| | Their self-efficacy belief in the measurement and evaluation process | 3.85 | 0.58 | 4.17 | 0.68 |

**Table 2: The paired sample t-test results for OSCA and SSICA pretest–post-test scores**

| | | N | $\overline{X}$ | sd | t | p |
|---|---|---|---|---|---|---|
| **OSCA** | **Pretest** | 32 | 3.93 | 0.48 | -3.413 | 0.002 |
| | **Post-test** | 32 | 4.35 | 0.55 | | |
| **SSICA** | **Pretest** | 32 | 3.83 | 0.51 | -3.019 | 0.005 |
| | **Post-test** | 32 | 4.15 | 0.63 | | |

**Table 3: The multiple regression analysis results for the prediction of achievement**

| Variable | Unstandardized coefficients B | | Standardized coefficients | t | p | zero-order | partial |
|---|---|---|---|---|---|---|---|
| | B | Std.Error | β | | | | |
| **Constant** | -.118 | .192 | | -.611 | .546 | | |
| **View of the constructivist approach** | .178 | .049 | .619 | 3.665 | .001 | .635 | .563 |
| **Self-efficacy belief for implementing the constructivist approach** | .008 | .042 | .030 | .177 | .861 | .356 | .033 |
| $R=.635$, $R^2=.403$, $F_{(2,29)}=9.798$, $p= .001$ | | | | | | | |