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The Effect of Storylines Embedded within Context Based Learning Approach on Grade 10 Students' Achievement of Mixtures Unit

Hulya DEMIRCIOGLU
Karadeniz Technical University, Fatih Faculty of Education

Funda DEMETGUL
Penpe İzzet Şahin Güzel Sanatlar Lisesi

Abstract: The purpose of the present study was to investigate the effect of storylines embedded within the context-based learning approach on grade 10 students' achievement of the mixtures unit and attitudes towards chemistry. Within a quasi-experimental design, the study was conducted with conducted with 48 10th grade students drawn from two intact classes in a high school. One of classes was randomly assigned to experimental group and the other to control group. The experimental group was exposed to the context-based materials, while the control group was taught with the traditional approach (teacher's explanation, question and answer, writing, etc.). The teaching intervention which took a couple of classroom hours (2x45 minutes; 8 weeks) in the experimental group was designed to actively engage the students in the context based learning. *The Mixtures Unit Achievement Test (MUAT) and Chemistry Attitude Scale (CAS)* were used to collect data. *MUAT* with ten open-ended items was constructed by the authors. The results of this study indicated that the use of storylines embedded within the context-based learning approach resulted in the students in the experimental group performing better with respect to understanding concepts in the mixtures unit. Some suggestions are made on implications for practice and learning.

Keywords: Context-based learning approach, Mixtures unit, Attitude, Chemistry

Introduction

Learning is not an isolated activity from the outside world, but a social activity influenced by everyday contexts (Finkelstein, 2001). However, the learning activity that is attempted to be realized in schools is confronted as a process that is completely abstracted from the outside world, schools are considered to be the places where only the theoretical knowledge is given and the more you solve test the better student you are is the predominant logic.

This situation has led students to not be able to relate the information they learned in school to their own lives, to fail to adapt their knowledge to out of school life, so that results in a profound gap between school and everyday life. In order to fill this gap between the daily lives of the students and the school lessons, it is necessary for the students to be informed about the conscious of interpreting the topics they learn in daily life (Koçak, 2011).

The goal in science education is to ensure that students acquire the scientific attitudes and mental process skills required to solve problems related to science that they may encounter throughout their lives to the extent that they are capable (Ulusoy, 2013). When we draw more attention to it, the secondary chemistry program aims to raise awareness of chemical concepts and principles that affect their lives (MONE, 2007). With this in mind, new approaches have been developed for students to adapt the scientific knowledge they have learned at school to the solitions of the problems they encounter and thus to achieve their predicted skills (Fensham & Harlen, 1999; Bayrak & Erden, 2007). Context based learning is also one of these approaches.

The context-based learning approach is concerned with associating science with events that students encounter in their daily lives and expressing science in a social context (Demircioğlu, 2008). The aim of this approach is to increase the students' desire to learn science, their attitudes and their motivation by presenting scientific

concepts through selected contexts in everyday life (Barker & Millar, 2000, Demircioglu, Demircioğlu & Çalık, 2009, Özay-Köse & Çam-Tosun, 2011). In studies conducted for this purpose, it was concluded that it made positive developments to the attitudes and behaviors of the students in general, and that students found it quite interesting and entertaining (Ramsden, 1997, Reid, 2000, Demircioğlu, Vural & Demircioğlu, 2012, Demircioğlu, Bektaş & Demircioğlu, 2018).

Context-based learning approach makes the learned knowledge a necessity starting from a daily life event or problem, and thus aims to use concepts and associations as a tool to solve these events and problems (Acar & Yaman, 2011). In this respect, it also contributes to the constructing of students' minds on the basis of the need to know concepts (Demircioğlu, Demircioğlu & Çalık, 2009, Ültay, Durukan & Ültay, 2017) as well as the answer to the question "Why should I learn this? (Bulte, Westbroek, De Jong & Pilot, 2006, Pilot & Bulte, 2006, Box, 2011). With context-based learning, students make it easier to understand existing situations and identify them connecting events, phenomena and situations one another in everyday life (Yıldırım & Gültekin, 2017). The narratives involved in this approach relate the theoretical knowledge with the real world (Bennett & Lubben, 2006). These narratives are used to communicate ideas, make meaningful ideas, and present the content of the curriculum (Banister & Ryan, 2001; Millar & Osborne, 1998). Students' understanding of concepts may develop as they discover by means of narratives (Demircioğlu, 2008), and thus narratives constitute an important awareness for viewing events of daily life from the chemistry aspect.

The purpose of the present study was to investigate the effect of narratives embedded within the context-based learning approach on grade 10 students' achievement of the mixtures unit. Within this aim, the following research questions are specifically explored:
1. Do the narratives embedded within the context-based learning approach cause a statistically significant change in students' achievement on the mixtures unit?
2. Do the narratives embedded within a context-based approach cause a statistically significant improvement in the students' attitudes towards chemistry?

Method

Participants

Within a nonequivalent pretest-posttest control group design, the study was conducted with 48 10th grade students (whose ages were 15-17 years old) drawn from two intact classes in a fine arts high school in Ordu. The experimental (with 25 students) and the control groups (with 22 students) were randomly assigned to them. The students in the two groups had similar educational and socio-economic backgrounds.

The experimental group was exposed to the context-based material, whilst the control one was taught with the traditional approach (teacher's explanation, question and answer, writing, etc.).The traditional instruction in the school was strongly based on the teacher centered format. In this format, students were passively listening, writing notes and reading textbook material. The topics and acquisitions in the Mixtures unit are given in Table 1.

Table 1. The topics and acquisitions in the Mixtures Unit

Topics	**Acquisitions**
Homogeneous Mixtures **Heterogeneous Mixtures**	1- Mixtures which are encountered in daily life are classified according to different qualities. a. How homogeneous and heterogeneous mixtures are distinguished is handled. b. Heterogeneous mixtures are classified according to dispersing medium and the physical state of the dispersing medium. c. Mixtures are classified by size basis. d. The difference of solution from other blends is emphasized.
Coligative Properties	2- It interprets the properties of the solutions related to everyday life, a. It is stated that the solubility is different from those of the solvents such as freezing / boiling point and osmotic pressure, and that the difference grows as the concentration increases (no entry dropping off the vapor pressure) b. It addresses some studies on measures against icing on roads and on vehicles. c. The prospect of using serum (lifesaving solutions) instead of drinking water for water-losing individuals is associated with osmotic pressure.
Separation of	3- it explores the separation techniques used in industry and health areas.

Mixtures	**a.** Separation techniques such as particular size, boiling point, forming filtration, dialysis, distillation and phase utilizing from density difference are processed. **b.** The discovery of the coagulation method used in water refinement is provided. **c.** Ion exchange systems used for softening hard waters are introduced

Data Collection

The Mixtures Unit Achievement Test (MUAT)

A test consisting of 10 open-ended items was developed by researhers. To confirm content validity, the MUAT was examined by a group of experts comprising four university chemistry educators and five high school chemistry teachers who have been teaching for over ten years at the central lycees in the city of Trabzon and Ordu. The MUAT were piloted with thirty-four grade 10 students to check its readability and understandability. Then, some minor revisions were made in the light of the results of the pilot study to produce their final versions. In the MUAT, each correct response (choice) was marked with 10 point, while each incorrect one was scored with zero point. Thus, for the MUAT the maximum score was 100 points.

Chemistry Attitude Scale (CAS)

A 12-item scale developed by Cheung (2009) as a result of a comprehensive study and adapted to Turkish by Şenocak (2011) was used as attitude scale in the study. This scale is an attitude scale developed for high school students covering 16-19 age range. The Cronbach alpha reliability coefficient of attitude scale was calculated as 0,88 by Şenocak (2011). The scale consists of four dimensions: liking theoretical chemistry lessons, liking chemistry labs, evaluating beliefs about school chemistry, and behavioral trends toward learning chemistry. There are no negative expressions on the scale. Since some researchers have suggested that negative materials written as the opposite of positive materials may cause an artificial factor (Schmitt & Stults, 1985, Pilotte & Gable, 1990; Miller & Cleary, 1993), they did not use negative substances on the scale to prevent this artificial factor from forming. The grading of the scale varies from 1 to 7. The highest score that can be taken from attitude scale is 84, the lowest score is 12.

Data Analysis

The results of the pre-test, post-test, and the chemistry attitude scale were compared using independent *t* tests.

The Intervention

To identify students' achievement of the mixtures unit and to identify students' attitudes towards chemistry, the MUAT and CAS, as a pre-test, was administered to both groups a week before the intervention. The students in the control group were exposed to a teacher-centered approach, which includes the teacher's explanations, students taking notes and referring to the textbook for examples and illustrations.

In the experimental group, the context-based learning material (CBTLM) was used to teach the topic of Change of States. The material for 8 weeks (2x45 minutes; two lessons per week) was designed to actively engage the students in the context based learning. Each lesson plan consisted of a storyline and related activities (i.e., pictures, virtual laboratory work, worksheets, discussing). The storylines 'My Mother and Her Kitchen (Story 1), Black Winter (Story 2), and My Summer Vacation (Story 3)' were prepared by the authors. One of the storylines is given in Appendix 1. Lessons are conducted by the second author of the study.

The authors preferred the teaching model developed by King (2009) for the context-based learning approach. The teaching and learning sequence of each lesson had the following pattern: start with a context, investigate a solution through a context-based problem, identify the heat concepts within the context and apply these concepts to new contexts.

1. *Start with a context*: Each lesson started with a context to focus student attention. The context was set to probe student prior knowledge and understanding at the beginning of a lesson. Student prior knowledge was elicited through brainstorming, discussion or testing intended to help students see how the science concept related to their lives and experiences. At this stage, the storylines prepared by authors were used.

2. *Investigate a solution through a context-based problem*: Students were encouraged to answer the questions or solve problems that they faced in step 1 through experiments, demonstrations, reading assignments, group and class discussions of reading assignment, and/or by working through examples or exercises. At this stage, the students made experiments on the subject in the virtual environment (URL, 1) and answered the questions about the concepts in the experiments. Experimental topics are; homogeneous and heterogeneous mixtures, separation of liquid mixtures by boiling point difference, separation of solid two substances by solubility difference, filtration of cloudy water, separation of solid two substances by density difference, freezing point descent and osmotic pressure.

3. *Identify concepts through the context*: The teacher encouraged students to report the results of their investigations back to the class, to discuss and make summaries of homogeneous mixture, heterogeneous mixture, osmotic pressure, separation of mixtures, freezing point descent, etc. concepts. At this stage, the students prepared concept maps related to the subject and performed activities with the diagnostic tree technique of the concepts. They shared the results of their work with their friends.

4. *Apply concepts to new contexts*: Students were presented with at least one new context which linked to the concepts they had learned and were asked to explain the new contexts. The students searched the related daily life topics (such as What is antifreeze? What is the anti-freeze on the car radiator?; Why isn't the water given to the patient suffering from water loss directly but why is serum given ? What could be the reason for this?; How did the travertine form?) and presented them with their classmates.

Results and Discussion

Pre-MUAT scores and pre-CAS scores for the experimental and the control groups are presented in Table 2, which shows that they have very close mean scores and standard deviations. The independent *t*-test indicated that there was no statistically significant difference between the mean scores of the groups with respect to the previous understanding of Mixtures Unit's concepts ($t_{(45)}$=0,681, p>0,05; Table 2). Similarly, there was no statistically significant difference between the mean scores of the groups with respect to students' attitudes towards chemistry ($t_{(45)}$=0,106, p>0,05; Table 2). These results indicate that students in the experimental group were very similar to those in the control one in regard to these two variables.

Table 2. The results of the *t*-test on pretest scores of students in the experimental and the control groups

Test	Group	N	Mean	SD	*df*	*t*	*p*
Pre-MUAT	EG	25	13,520	12,018	45	0,681	0,501
	CG	22	11,773	11,197			
Pre-CAS	EG	25	39,920	12,952	45	0,106	0,916
	CG	22	39,500	14,138			

After the intervention, the results of the independent *t* test showed that there was both a significant difference between the experimental and control groups with respect to students' achievement of mixtures unit ($t_{(45)}$=6,175, p<0,05; Table 3), and also with respect to the chemistry attitude scale ($t_{(45)}$=2,872, p<0,05; Table 3). This finding revealed that the students in the experimental group taught with the context-based approach exhibited significantly greater chemistry achievement than those in the control group on the post-tests. Since the only independent variable was the intervention, it can be concluded that this difference may have resulted from the context based learning approach. That is, as if the traditional instruction helped students to improve their conceptions of the mixtures unit' concepts to some extent, their retention was very lower than that of the experimental one. Developed materials and contexts related to everyday life have attracted the attention of students and may have given them a more relevant approach to the subject. It can be said that the use of contexts related to everyday life in the context-based learning approach allows the learned information to be remembered better, which in turn increases academic achievement.

Table 3. The results of the *t*-test on posttest scores of students in the experimental and the control groups

Test	Group	N	Mean	SD	df	*t*	*p*
Post-MUAT	EG	25	63,800	13,026	45	6, 175	0,000
	CG	22	40,136	13,203			
Post-CAS	EG	25	53,320	13,704	45	2,872	0,006
	CG	22	42,272	12,506			

Conclusions and Implications

When the final test scores of the experimental and control groups were examined, it was found that there was a significant difference in the Mixtures Unit Achievement Test (MUAT), Chemistry Attitude Scale (CAS) scores in favor of the experimental group. In this case, it can be said that the study based on context-based learning is effective on both sides. This result is consistent with studies reporting that students taught with the context-based learning approach have a better understanding of the concepts from the students taught with a more traditional approach(Demircioğlu, 2012, Çiğdemoğlu & Geban, 2015, Ayvacı, Nas & Dilber, 2016, Demircioğlu, Aşık & Yılmaz, 2017;).

The context-based activities used in the lessons, especially the narratives are found interesting by the students, students have been seen more motivated and they liked the lessons. It is thought that the interest of the students to the lectures is increased as they have learned by doing and experiencing and they are aware of the learned items as a tool of their life. When the literature is examined, it is concluded that after the lessons in which the context-based learning approach is used, the students have liked the process, performed permanent learning (Demircioğlu, Vural & Demircioğlu, 2012; Ültay, Durukan & Ültay, 2015) and real-life associations facilitate students to understand concepts (Choi & Johnson, 2005; Demircioğlu, Vural & Demircioğlu, 2012; Demircioğlu, Ayas, Demircioğlu & Özmen, 2015; Elmas & Geban, 2016; Karslı & Yiğit, 2017). It has also been reported by many studies that the interest and success have changed in parallel (Koçak & Önen, 2012; Tay & Akyürek Tay, 2006). In this respect, the context-based learning approach emerges as a way of responding to the needs of the students. The obtained data also supports this situation.

The stories should be used as a starting point to teach the concepts of chemistry, and the concepts that students have difficulty to understand should be taken into consideration when preparing the stories. The stories should be appropriate for the students and motivate them to study on the concepts of chemistry.

This study has been applied at Fine Arts High School. Because of the prejudice of inability of the learners and their perspective on Cultural Lessons the learning of the students is incomplete no matter how effective the course is. This study is applicable to different schools and the study results can be comparable.

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Author Information

Hulya Demircioglu
Karadeniz Technical University
Fatih Faculty of Education

Funda Demetgul
Penpe İzzet Şahin Güzel Sanatlar Lisesi RR
Contact e-mail: fundademetgul61@gmail.com

Appendix 1 One of the storylines used in the study

My Mother and Her Kitchen




Ayşe is a hardworking, intelligent student who observes the environment very well. After reading the book, the thing she likes most is to help his mother at home. Ayşe told the day she lived with her mother in the kitchen.

When I came home from school, my mother was boiling milk in the kitchen. She did not leave from the oven for a moment. Then she was going to ask me how my day went. Milk suddenly flooded. At that moment, the question came up to my mind, "Why does the milk overflow from the pan when it is about to boil?"

Our guests would come last week. My mom made a very tasty and famous tie dessert. She did pour 2.5 cups of sugar into 2 cups of water in front of my eyes! I was shocked. 2.5 cups of sugar almost disappeared. How did this happen? Could a hocus pocus be? :)

What about the Russian salad? When so many ingredients come together such as pickles, peas, carrots, potatoes, corn, and of course mayonnaise and yogurt, it becomes so delicious! My mother says it a magic mixture. Do you think how is the mayonnaise made? Why don't we see the things in mayonnaise.

My mom made me a quick sandwich because I was so hungry. What was't there in it? Cheese, salami, tomato, pickle, lettuce ... Ahh it was super! And it would be better if I could taste them all in the same bite. A different food was coming into my mouth in each bite. How can we explain this situation?

I left the kitchen saying whom I could learn the answers of these questions and I headed towards my room.

Come on!
Let's help Ayşe.
What do you say?