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Effects of 5E Learning Cycle on Students' Human Circulatory System Achievement

Özlem SADI[1,2] Jale ÇAKIROĞLU[3]

[1] Department of Educational Science, Karamanoğlu Mehmetbey University, Karaman, TURKEY

[2] Department of Secondary Science and Mathematics Education, Faculty of Education, Middle East Technical University, Ankara, TURKEY

[3]Department of Elementary Education, Faculty of Education, Middle East Technical University, Ankara, TURKEY

[*]**Corresponding Author**
e-mail: sadi@kmu.edu.tr

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Abstract

This study aimed to investigate the effectiveness of 5E learning cycle instruction on 11th grade students' human circulatory system achievement. In this study, The Human Circulatory System Achievement Test was used to assess students' achievement on human circulatory system. Two teachers and four classes and total of 60 11th grade students were participated in this study. One class of each teacher was assigned as experimental group and treated with 5E learning cycle instruction and other class was assigned as control group and treated with traditional instruction. The Human Circulatory System Achievement Test was applied twice as pre-test and after treatment period as a post-test to both experimental and control groups to measure students' achievement. ANOVA results revealed that 5E learning cycle instruction improved students' achievement in human circulatory system compared to traditional instruction.

Keywords: Human Circulatory System, biology achievement, learning cycle, traditional instruction.

INTRODUCTION

All through the last century, researchers offer alternative strategies to support meaningful learning in biological concepts in different countries and there have been different arrangements to active participation of students in biology instruction. Rutherford and Ahlgren [1] pointed that young people should see, handle, contact, operate and change situations that consent to them to investigate what is happening in science. Since the students need the process skills when doing scientific investigations and during their learning, instructional strategies have been developing in which learners become active contributors of their learning. One of the teaching strategies based on inquiry is the learning cycle.

The learning cycle can be defined as an activity oriented teaching methods and promote students meaningful understanding of scientific concept, explore and deepen that understanding, and then apply the concept to new situations [2].

Karplus and Their [3] explained the learning cycle model that initially includes three phases as exploration, term introduction and concept application. Even though Karplus is generally viewed as the "father" of this model of instruction, learning cycle model roots go back to the developmental learning theories of Piaget. In exploration phase, the student explores a concept by doing hands-on activities or experiments. When students explore new concepts, the students remember previous experiences or assimilate new concrete experiences helpful for presently discovery. This creates disequilibria in the students and they need to accommodate the concepts to reach equilibrium. In term introduction phase, the teacher collects information from the students, with regard to their exploration experiences. The students explain or define their ideas and the teacher introduces new subjects. As subjects are introduced in this phase, the teacher gives a chance to students who interrelate with the new subject and with their teacher and peers. This interrelation gives rise to help the students assimilate or accommodate specific ideas. In the concept application phase, students try to use these new subjects in different situations. Teacher encourages students for additional physical and social interaction. Learning cycle also includes 5, namely 5E learning cycle model. Each 'E' in the Five Es model represents a specific phase in the model – namely, Engagement, Exploration, Explanation, Elaboration and Evaluation. Engagement promotes interest and motivation [4].

There are many studies carried out to assess the effectiveness of learning cycle [5-14]. According to these studies, learning cycle encourages students to develop their own understanding of a scientific concept and so promotes conceptual change while providing better understanding of scientific concepts.

This study was conducted to see if 5E learning cycle instruction can be used to increase students' biology achievement of 11th grade students in Turkey under the topic of human circulatory system. Human circulatory system is one of the most important and difficult topics of the biology curriculum. Major concepts of circulatory system which the students do not fully understand are shown in the research as structure and functions of human cardiovascular system, pumping mechanism of heart, circulatory/respiratory relationships, and systemic/pulmonary circulation, closed circulation, type of blood vessels, and homeostasis, and the blood flow rate [15-20]. Students' understanding of the human circulatory system concepts related with their understanding of the main concepts of homeostasis, as circulating blood is fundamental for the maintenance of stable internal environment in the body. Thus, students can understand the relation of body systems with each other when they understand how blood circulation mechanism works in human body and realize the central role of the circulatory system in homeostasis [20]. Therefore, students should connect each circulatory system concepts with each other in a meaningful way in order to recognize further biological concepts better such as digestive system concepts, immune system concepts and respiratory system concepts. That means that meaningful learning of circulatory system concepts has become an important issue to understand other important biological systems' concepts.

PURPOSE

The main purpose of this study is to investigate the effects of 5E learning cycle instruction related to human circulatory system on 11th grade students' biology achievement. The following research question framed this study:

What are the effects of methods of teaching (5E learning cycle instruction versus traditional instruction) on the population means of 11th grade students' biology achievement posttest scores?

METHODS

1. Sample

The present study was conducted with 60 11th grade students (17 years of age) from 4 classes of 2 teachers in a private high school in Ankara, Turkey. Each teacher had one experimental and one control groups. There were 31 students in experimental group which was taught with 5E learning cycle instruction and 29 students in control group taught by traditional instruction.

2. Instruments

Two measuring tools were used in this study named as Human Circulatory System Achievement Test (HCSAT) and observation checklist.

2.1. Human Circulatory System Achievement Test (HCSAT)

The HCSAT developed by the researchers was used to assess students' achievement about human circulatory system. It covers the science content present in the 11th grade biology curriculum. It consists of 25 multiple choice questions related with all of human circulatory system such as blood, blood vessels, pumping mechanisms and the structures of heart, the systemic circulation and the pulmonary circulation. Possible HCSAT scores range from 0 to 25, with higher scores showing greater achievement in human circulatory system topic.

The HCSAT was administered as a pretest and posttest to both control and experimental groups to assess students' biology achievement about human circulatory system. The researchers preferred to use multiple choice questions as a test questions due to ease of application and objectivity. Reliability was found to be 0.68.

2.2. Observation Checklist

During the treatment, both the control and the experimental groups were observed to identify whether the teachers follow the treatment rules. The observer used the checklist consisted of 12 items, two of which were negative form for the hands-on activity criteria. First 10 items rated on five-point response format that indicate how frequently some actions were done. In addition, one item indicates whether the activities were done alone, in pairs or in groups of three and other item shows how much time the students spend on doing hands-on activities, were designed to be rated on four-point response format. Each item conclude with "no activity" option to check whether the control group done any activity or not. Two researchers observed both experimental and control group classes during the study and filled the observation checklist for both groups.

3. Treatment

Experimental research as a research methodology was favored since it is the best way to establish cause and affect relationships between variables. A quasi-experimental study design was preferred as an experimental model since it does not include random assignment.

The biology course consisted of three 40-min lessons per week. At the beginning of the study, the teachers were trained by the researchers; and given a handout indicating what they should do during the 5E learning cycle instruction. By this way, teachers could know how to teach human circulatory system in both experimental and control group. Moreover, the teachers allowed researcher to observe their classes.

Two measuring tools were used in this study. The one (HCSAT) was used to assess students' achievement about human circulatory system and the other, observation checklist was used to confirm proper treatment implementation. HCSAT was applied to both groups as a pretest one week before the treatment. In addition, some background information was collected from the students such as their age, gender, mother education, and father

education. Test application took approximately one class hour for pre-test and post-test separately.

The students in control groups and the experimental groups treated with different methods of teaching. In control group, traditional method was used. Teacher-centered instruction was applied and students were generally taught with note taking strategy. The teacher gave important concepts about human circulatory system. The teacher used some diagrams about the subjects. On the other hand, in experimental group, 5E learning cycle instruction was used. For each phase of 5E learning cycle, different activities (Table I) were prepared. The subject of human circulatory system was expressed with four general titles as heart, blood vessels, blood circulation and blood pressure by taken into consideration of 11th grade biology curriculum of Ministry of Education (MEB). Therefore, 5E learning cycle plan was prepared for topics of heart, blood vessel, blood circulation, and blood pressure.

Observation checklist was used for both groups during the study to confirm proper treatment implementation. The checklist showed the degree to which the course was taught with 5E learning cycle activities. Finally, HCSAT was applied as a posttest after treatment for control and experimental groups. Test scoring was done and computed.

RESULTS

The mean, median, mode, standard deviation, skewness and kurtosis were presented for both control and experimental groups for the HCSAT scores are presented in Table II.

As presented in Table II, the experimental groups showed mean increase ranging from 6.16 to 15.29 in their level of biology achievement from the pretest to posttest. However, the control group showed a mean increase ranging from 7.41 to 9.72 in their level of biology achievement from the pretest to posttest. Therefore, experimental group shows a mean increase of 9.13 whereas the change in control group is 2.31 points on the HCSAT. Therefore, it can be said that the experimental group students gained more biology achievement than the control group students as indicated in Figure 1.

Table I. 5E Learning cycle activities about human circulatory system

Content	Name of activities
Heart	1. Exploration of heart 2. Exploration of human heart 3. Structure of the heart 4. The mechanisms of heart function
Blood Vessels	1. Exploration of blood vessels 2. Structure of blood vessels
Blood Circulation	1. Understanding of blood circulation 2. Systemic and pulmonary blood circulation
Blood Pressure	1. Blood Pressure 2. Counting of pulse 3. Measuring tension

For inferential statistical analyses, α was set to 0.05 (probability of making Type-1 error) that is mostly used value in educational studies. Effect size was set to small in this study (f2= 0.3 for mean difference and 0.08 for variance).

ANOVA model was used to test the hypothesis of this study and assumptions of ANOVA are as follows; normality, homogeneity of variances and independency of observations and these assumptions were also verified. The null hypothesis was "There is no significant effect of learning cycle instruction on 11th grade students' understanding of human circulatory system". ANOVA was conducted to determine the effect of methods of teaching on the students' human circulatory system achievement post-test scores (PSTACH).

Significant differences were found between learning cycle instruction and traditional method on the dependent variable ($F(1, 28) = 2.136$, $p=.000$). The statistical analysis of ANOVA indicates that the students instructed by 5E learning cycle instruction gained more biology achievement about human circulatory system than the students instructed by traditional method.

DISCUSSION AND IMPLICATIONS

The results of this study show that 5E learning cycle instruction increased students' achievement in biology more than the traditional instruction did. According to results, learning cycle instruction formed better attainment of human circulatory system concepts compare to

Table II. Descriptive Statistics for the Biology Achievement Scores

	Experimental Group		Control Group	
Scores on Human circulatory system Achievement Test	Pretest	Posttest	Pretest	Posttest
N	31	31	29	29
Mean	6.16	15.29	7.41	9.72
Standard Deviation	2.03	3.65	2.48	2.03
Skewness	0.63	-0.806	-0.103	0.308
Kurtosis	-0.306	-1.82	-0.374	0.114
Range	11	14	11	17
Minimum	1	7	2	5
Maximum	12	21	13	22

traditional instruction. This result illustrates consistency with the role of learning cycle which is a model of instruction based on scientific inquiry. Findings of this study are in agreement with other studies related with subjects [13, 14, 21, 22]. In one of these articles; Barman et al. [21] compared the learning cycle teaching approach with a textbook demonstration method of instruction. The aim of their study was to investigate whether one method was more effective in facilitating conceptual change concerning sound. The result of this study showed that learning cycle is an effective teaching model in helping students refining their ideas about science concepts. Likely, Atay and Tekkaya [14] examined the comparative effect of the learning cycle and expository instruction on 8th grade students' achievement in genetics. According to statistical analyses of ANCOVA, there was significant post treatment difference between two groups in the favor of the experimental groups after learning cycle instructions. Balci et al. [13] examined the effects of 5E learning cycle, conceptual change text and traditional instructions on 8th grade students' understanding of photosynthesis and respiration in plants. According to analyses of data, there were significant differences between the experimental and control groups in which students who instructed by 5E learning cycle and conceptual change text instruction had better score from post-test than students who instructed by traditional instruction. On the other hand, there was no significant difference between 5E learning cycle instruction and conceptual change text instruction.

As a conclusion, the results of the study offered the use of learning cycle as an alternative teaching strategy for providing students' better understanding of human circulatory system concepts. One important implication of this study is that teachers should ensure their students become active and so biology lesson should be student-centered but not to be teacher-centered. Secondly, students performed activities by group work which fosters a deeper and more active learning process. To sum up, learning cycle is a model of instruction based on scientific inquiry and encourages students to develop their own understanding of a scientific concept. This study performed with 11th grade students and only one biology subject; however, future studies can examine the effects of 5E learning cycle instruction in different biology subjects and grade levels.

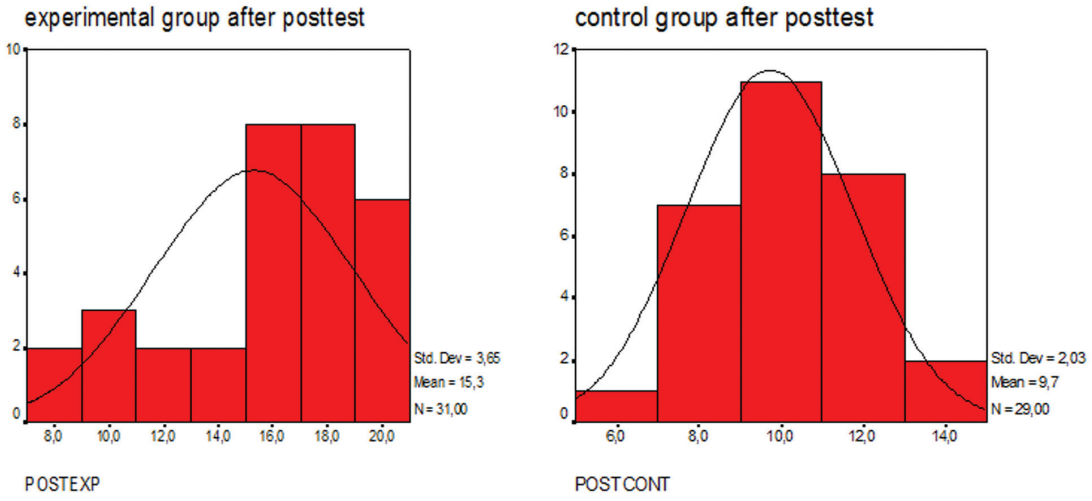

Figure 1. Histograms with normal curves of the Posttest scores in both experimental and control groups

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