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THE EFFECT OF 5E LEARNING CYCLE MODEL IN TEACHING PHYSICS ON STUDENTS' ACADEMIC ACHIEVEMENT AND THE PERMANENCE OF THEIR KNOWLEDGE

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Abstract- The implementation of inquiry-based teaching is a major theme in national science education reform documents such as *Project 2061: Science for All Americans* (Rutherford & Alhgren, 1990) and the *National Science Education Standards* (NRC, 1996). These reports argue that inquiry needs to be a central strategy of all science curricula**.** Using a learning cycle approach in the classroom helps to facilitate inquiry practices because learning cycles focus on constructivist principles and emphasize the explanation and investigation of phenomena, the use of evidence to back up conclusions, and experimental design. Although there are several variations of learning cycles, the one that is highlighted in this manuscript as a method to support inquiry-based teaching is the 5E Instructional Model (Bybee & Landes, 1990). The use of this model in several science education professional development programs is also addressed.

Keywords: 5E Instructional Model, National Science Education Standards (NRC, 1996), inquiry-based teaching

I. INTRODUCTION

The 5e learning cycle is an instructional design model that defines a learning sequence based on the on the experiential learning philosophy of John Dewey and the experiential learning cycle proposed by David Kolb. Attributed Roger Bybee of the Biological Science Curriculum Study (BSCS), the model presents a framework for constructivist learning theories and can be effectively used in teaching science.

Enquiry based learning

Inquiry-based learning is an approach to learning that emphasizes the student's role in the learning process. Rather than the teacher telling students what they need to know, students are encouraged to explore the material, ask questions, and share ideas.

Inquiry-based learning uses different approaches to learning, including small-group discussion and guided learning. Instead of memorizing facts and material, students learn by doing. This allows them to build knowledge through exploration, experience, and discussion.

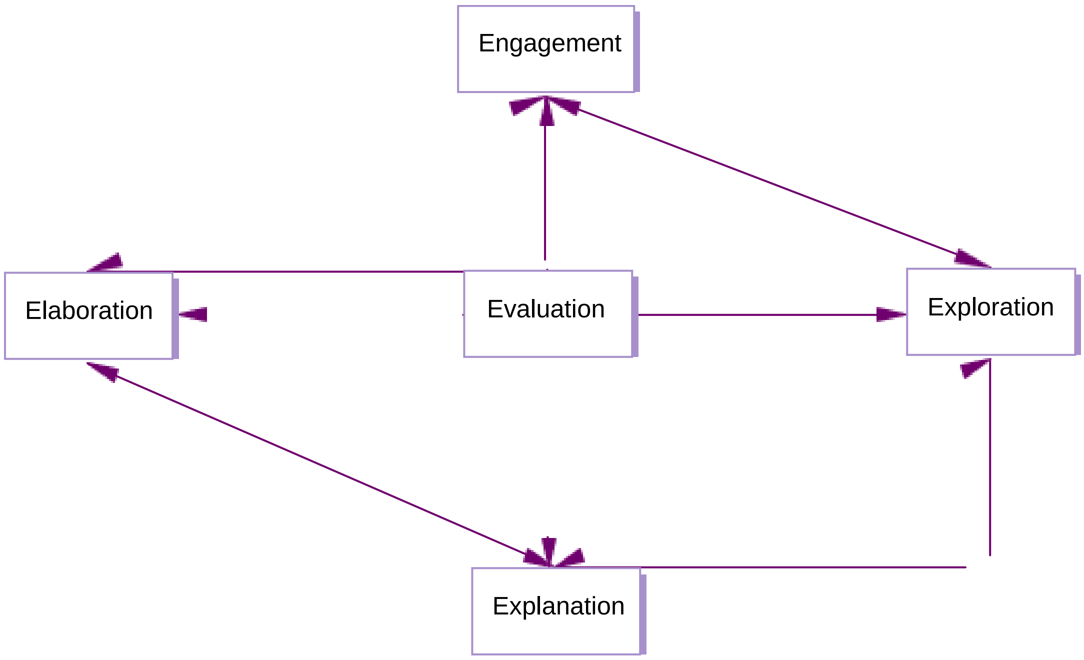
Effective of enquiry based learning

inquiry-based learning actively engages students in the learning process. Students aren't just hearing or writing what they are learning. Instead, students get the chance to explore a topic more deeply and learn from their own first-hand experiences. We retain 75% of what we do compared to 5% of what we hear and 10% of what we read. Inquiry-based learning allows students to better understand and recall material by actively engaging with it and making their own connections.

Model

Engage

Here the task is introduced. Connections to past learning and experience can be invoked. A demonstration of an event, the presentation of a phenomenon or problem or asking pointed questions can be used to focus the learners' attention on the tasks that will follow. The goal is to spark their interest and involvement.



Explore

Learners should take part in activities that allow them to work with materials that give them a 'hands on' experience of the phenomena being observed. Simulations or models whose parameter can be manipulated by learners, so that they can build relevant experiences of the phenomena, can be provided. Questioning, sharing and communication with other learners should be encouraged during this stage. The teacher facilitates the process.

Explain

The focus at this stage is on analysis. The learner is encouraged to put observations, questions, hypotheses and experiences from the previous stages into language. Communication between learners and learner groups can spur the process. The instructor may choose to introduce explanations, definitions, mediate discussions or simply facilitate by helping learners find the words needed.

Elaborate/Extend

Using the understanding gained in the previous stages, now learners should be encouraged build and expand upon it. Inferences, deductions, and hypotheses can be applied to similar or real-world situations. Varied examples and applications of concepts learnt strengthen mental models and provide further insight and understanding.

Evaluate

Evaluation should be ongoing and should occur at all stages, in order to determine that learning objectives have been met and misconceptions avoided. Any number of rubrics, checklists, interviews, observation or other evaluation tools can be used. If interest in a particular aspect or concept is shown, further inquiry should be encouraged and a new cycle can begin that builds upon the previous one. Inquiries may branch off and inspire new cycles, repeating the process in a spiralling fractal of interrelated concepts, where instruction is both structured and yet open to investigation.

Applications of the 5E Instructional Model

The 5E instructional planning model has been integrated, as a core instructional design strategy, in many science classrooms in the Northwest Ohio region.
Specifically, it has been a significant part of the reform-based professional development programs conducted by science educators and scientists from Bowling Green State University and The University of Toledo. This group has worked with K-12 educators to create 5E lessons and unit plans that support science courses of study and *The Ohio Academic Content Standards for Science*.

Included in these grant-funded programs are TAPESTRIES (Toledo Area Partners in Education - Support

Teachers as Resources for Improving Elementary Science), a 5- year project funded by the National Science Foundation, and Project ASTER (Active Science Teaching Encourages Reform), a 2-year project funded by the Improving Teaching Quality Program of the Ohio Board of Regents. Both projects are collaborative efforts between two large midwestern universities and urban and suburban school districts. Major goals of both projects are to:

1. provide effective and sustained professional development in science content, pedagogy, and assessment for elementaryteachers,
2. implement quality inquiry-based science curriculum andinstruction,
3. coordinate curriculum, classroom practice, and student assessment with the district-adopted science courses of study and statewide curriculum models and assessments,and
4. enhance the science content knowledge of elementary teachers in life, physical, and earth/space science.

Although the projects differ slightly in their academic year activities, a core 2-week summer institute experience is similar for all of the teachers. The summer institute is designed to encourage teachers to explore their district-adopted inquiry-based science kits in a hands-on fashion. A scientist and science educator team facilitates each session using 5E Models as the guiding framework. At the end of the summer institute, the teachers develop their own 5E unit plans based upon the needs of their students. Approximately 1,200 classroom teachers from the participating districts received extensive staff development in science content, pedagogy, and student assessment. A recent study released by The Urban Affairs Center from The University of Toledo reveals the positive effects and impact of theTAPESTRIESprogram on student achievement. A complete copy of the study is available from University of Toledo (n.d.).

A relatively new project, PRISM (Partnership for Reform through Inquiry in Science and Physics), is in its first year of implementation at Bowling Green State University with funding provided by the National Science Foundation's Graduate Teaching Fellows in K-12 Education Program. Teams consisting of a cooperating teacher and a natural science or physics graduate student are working to introduce hands-on inquiry in science and physics classrooms into four school districts. Approximately 25 teams, over a 3-year time frame, will develop comprehensive 5E Model unit plans that span the entire school year.

The ultimate goal of these projects is to improve student learning by conducting sustained teacher professional development. The projects were designed to help prepare scientifically literate students, who can comprehend and use science, while being successful on high-stakes statewide science assessments.

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II. METHODOLOGY

In this section, the information about the design of the research, the working group, the data gathering and the data analysis are mentioned.

Design of the research

The design of this experimental research is chosen as randomized pretest-posttest control group design. In this design, there exist two groups formed by random assignment. One of them is used as an experimental, the other as a control group. The students in the experimental group took the course about physics from the researcher in an environment where the 5E learning model based on the constructivist approach is used. The students in the control group took the same course without intervention of the researcher, from their physics teacher in an environment where the activities of official physics curriculum are used.

Working Group

The working group of this research consists of 49 students in12th grade students for of 2019-2020academic year to T.K.S.Higher secondary school in theni In the experimental group, there are 25 students (13 girls, 12 boys) and in the control group, there are 24 students (12 girls and 12 boys). When the experimental and control groups are determined, their physics their scores in the pre-test about dependent variable (academic achievement in Physics) are took into consideration and randomly the class section A and B are selected respectively as experimental and control group. If the effect of a new teaching method on learning is investigated in a research, the groups' equalization in gender and in past achievement is crucial (Büyüköztürk et al., 2008).

Students'physics' grades of 2019-2020 academic year Independent samples t-test is used to determine whether there is a statistically significant difference between experimental and control group students' Physics' grade.

Table:1 independent sample T test for Experimental and Control Group Students Physics

Group	Number of Students	Mean	Sd	Df	t	Sig
Experimental	25	3.265	1.75	42	1.65	N.S
Control	24	3.026	1.42			

As seen in table 1., there is no statistically significant difference between experimental and control group students' physics' grades [t(42) = 1.65, p>0,05]. As a result, before the start of experimental application, these two groups are considered as equal in their mathematical pre-knowledge.

Pre-test scores of students in the experimental and control group

Independent samples t-test is used to determine whether there is a statistically significant difference between experimentalandcontrolgroupstudents'scoresintheachievementtestforphysicsusedaspre-test.

Table 2: Independent Samples T-Test For Experimental And Control Group Students' Scores In ThePre-Test

Group	Number of Students	Mean	Sd	Df	t	Sig
Experimental	25	4.782	1.96	43	0.798	N.S
Control	24	4.268	1.56			

As seen in table 2., there is no statistically significant difference between experimental and control group students' scores in the achievement test for physics [t(43) = 0,798, p>0,05]. As a result, before the start of experimental application, these two groups are also considered as equal in academic achievement for physics.

Data Gathering

Academic achievement test is used to gather necessary data for the statistical analysis of research problem and to determine the effect of using 5E learning cycle model in teaching physics on students' academic achievement. Consisting of 50 questions, a test is prepared for measuring each acquisition of physics by at least 2 questions and it is applied to 120 students from upper grade. The content validity of the test are provided by a commission of five persons which are specialists in the field, in program development and in evaluation. After the pilot application, an item analysis is done, the item distinctiveness and the item difficulty index are checked. By eliminating depending on their proprieties, the final version of test which consists of 28 questions is prepared. The KR 20 reliability constant of the test is found as0,88.

This academic achievement test is used for several purposes: first of all, as a pre-test, it is applied to students in order to determine their pre-knowledge and readiness about physics. Moreover, as a post-test, it is used in order to determine the effect of teaching method. Finally, as a permanence test after one month later than post-test, it is applied in order to investigate the permanency of knowledge

Procedure of experimental application

Registered for of 2019-2020 academic year to an Theni kammavar sangam higher secondary school,theni, 12th grade students physics' grades and their scores in the pre-test about dependent variable which is the academic achievement in physics are took into consideration. As a result, the groups are found equal in mentioned variables and randomly the class 12 are selected respectively as experimental and control group.

The students in the experimental group took the course about physics from the researcher in an environment where the 5E learning model based on the constructivist approach is used. Before the beginning of the courses, course plans are prepared, checked and corrected by the specialists in thatfield.

A pilot study for testing the applicability of the course plans is done with another group that is independent of research. The research lasted 8 weeks (8*4=32 course hours).

The classroom and computer laboratories are used as environments for courses. Some teaching materials, which the physics teacher considered as necessary, are used by him. At the end of experimental application, the post-test is applied to both of the groups.

One month later, the academic achievement test is applied one more time as a permanence test.

Analysis of data

For the analysis of data obtained in research, SPSS15.0 (Statistical Package for the Social Sciences) package program is used. All the analysis is made in computer and statistical analysis methods, which are appropriate to the properties of data, are used.

III. FINDINGS

In this section, the findings from the analysis by SPSS15.0 of data obtained in research are presented with tables and graphics.Comparison of experimental and control group students' post-test scores The mean and the standard deviation of post-test scores of students in the experimental group, where the 5E learning model based on the constructivist approach is used, and of those in the control group, where the traditional teaching activities (lecture method, question-answer method etc.) are used, in academic achievement test about physics are given in the table3.

Table 3: Independent Samples T-Test For Experimental And Control Group Students' Scores In The Post-Test

Group	Number of Students	Mean	Sd	Df	t	Sig
Experimental	25	19.652	3.65	43	3.265	S
Control	24	21.65	2.89			

As seen in table 3., the mean of post-test scores of students in the experimental group is found as $\bar{X}$ = 19.652 and the mean of those in the control group is found as X = 21.65. It is determined that he mean of academic achievement of the experimental group is higher than the one of control group. Independent samples t-test is used to determine whether this difference is statistically significant. As a result, as t scoreis determined as 3.265with df = 43 and p=0,000, the difference between means is found statistically significant at the level of 0,05 significance.

These findings show that there is a learning level difference in favor of the experimental group. Thus, the 5E learning model based on the constructivist approach used in the experimental group is more effective in teaching physics that the traditional teaching methods used in the control group.

Findings about the permanence test scores

In this section, the findings about the students' scores in the permanence test which is used to determine the permanence of students' knowledge about physics are given. The permanence test is applied 4 weeks later than the post-test. The experimental and control group students' score in the permanence test are shown in the table 4.

Group	Number of Students	Mean	Sd	Df	t	Sig
Experimental	25	18.65	3.56	43	7.656	S
Control	24	14.36	2.12			

As seen in table 4., there is a statistically significant difference between experimental and control group students' scores in the permanence test in favor of the experimental group [t (43) =7.656 and p=0,000 < 0,05]. The permanence test scores of students in the experimental group, where the 5E learning model based on the constructivist approach is used, is higher than those in the control group. As a result, it can be interpreted that the physics learning by the activities appropriate to the 5E learning model based on the constructivist approach is more permanent that the traditional teaching.

IV. DISCUSSION AND RESULTS

As a result of this research, it is found that 5E learning cycle model effects not only the students' achievement but also the permanence of knowledge. The researches about 5E learning cycle models in both domestic and international literature are generally made in science education. Saka(2006), Lawson(2001), Balcı (2005), Bleicher (2001), Akar(2005) and Özsevgeç (2007) have researched the effect of 5E learning cycle model on academic achievement. The findings of this research show similarity to these mentioned researches.

A statistically significant difference is determined between experimental and control group students' scores in the post-test. By the analysis of findings, when their post-test scores are took into consideration, students in the experimental group, where the 5E learning model based on the constructivist approach is used, are found as more successful than those in the control group. A statistically significant difference is determined between experimental and control group students' scores in the permanence test. It is determined that this difference is in favor of the experimentalgroup.

In accordance with these results, some suggestions, thought as beneficial, are given below:

Physics teachers should provide opportunities to students for learning by exploring and reaching themselves to knowledge.The students should be asked to give all reasons of solving steps of the given problem. Whenever possible, the passage to the application should be done directly by students and also during the application, the mistakes and errors should be found directly by them. Teachers should only orientate students, help them Teachers should be careful about choosing teaching activities and working papers, which they want to use in the application of 5E learning model, in the sense that these materials should be attractive and appropriate to the students' level and also they provide opportunities for students to construct their own knowledge. This research is limited by the trigonometry subject. The effect of 5E learning model on other subjects in physics can be researched.

The students of the last grade in faculty of education should be asked to analyze and/or to research such models (5E learning model) as homework or project etc. Moreover, they should be asked to prepare course plans according to these models and to apply them, whenever possible. These course plan examples should be evaluated by the authorities. Such works provide opportunities for pre-service teachers to learn about these methods in other subjects of physics and also these teachers may use these methods when they begin to work.

REFERENCE

1. Akar, E., (2005). "Effectiveness of 5E Learning Cycle Model on Students" Understanding of Acid and

Base Concepts. Unpublished Master Thesis. Middle East Technical University, Ankara.
2. Altunay, D., (2004). “Oyunla Desteklenmiş Matematik Öğretiminin Öğrenci Erişine Ve Kalıcılığa Etkisi”. Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Yayımlanmış Yüksek Lisans Tezi, Ankara.
3. Balcı, S., (2005). “Improving 8th Grade Students‘ Understandin of Photosynthesis and Respiration in Plants By Using 5E Learning Cycle and Conceptual Change Text”. Unpublished Master Thesis. Middle East Technical University, Ankara.
4. Bleıcher, R. E., (2005). “Learning The Learning Cycle: The Differantial Effect on Elementary Preservise Teachers”.School Science and Mathematics.105(2),61-72.
5. Bruner,J.S.,(1972).ModelsofTheEducationalResearcher
6. Büyüköztürk, Ş., (2001). Deneysel Desenler: Ön Test Son Test Kontrol Gruplu Desen. Pegema Yayıncılık, Ankara. Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş., Ve
7. Bybee, R.W., (1997). Improving İnstruction. In Achieving Scientific Literacy: From Purposes To Practice. Portsmouth, Nh: Heinemann.
8. Caine, R. N., & Caine, G. (1990). "Understanding A Brain Based Approach To Learning And Teaching." Educational Leadership, 48(2), 66-70.
9. Campbell, M.A., (2000). “The Effects Of The 5e Learning Cycle Model On Students’ Understanding Of Force And Motion Concepts”. Ms Thesis. University Of Central Florida.
10. Carin, A. A. & Bass, J.E., (2001). Teaching Science As Inguiry. New Jersey, Ninth Edition. Prentice-Hall, Upper Saddle River.
11. Demirel, F. (2008). Bilimsel Araştırma Yöntemleri. Pegema Yayıncılık”, Ankara.
12. Ergin, G., Ünsal, Y. & Tan M. (2006). “5e Modeli‘Nin Öğrencilerin Akademik Başarısına Ve Tutum Düzeylerine Etkisi”: Yatay Atış Hareketi. Örneği. Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi. 7 (2),1-15.
13. Hançer, A. H., (2005). “Fen Eğitiminde Yapılandırmacı Yaklaşıma Dayalı Bilgisayar Destekli Öğrenmenin Öğrenme Ürünlerine Etkisi”, Doktora Tezi. Gazi Üniversitesi Eğitim Bilimleri Enstitüsü,Ankara.