Constructivist approach based 5E model and usability instructional physics

İsmet Ergin
Turkish Military Academy, Bakanlıklar 06654 Ankara, Turkey.

E-mail: ismet.ergin@gmail.com, or iergin@kho.edu.tr

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Abstract

In this study, the studies regarding the 5E model, which grounds on the constructivist approach in educational levels in the world and Turkey, and is used as an educational model and its properties were analysed and information were presented in respect of this model. In the study, which was performed in accordance with the descriptive scanning method in this research, primarily the papers, dissertations in magazines indexed in databases such as the Dissertation scanning center of the Board of Higher Education, Ebsco Host, Science Direct, Taylor and Francis and Web of Science etc. and the literature were scanned in a broad perspective. The dissertations, papers attained as a result of scanning were analysed by taking the grades of objective, conclusion and education into consideration. The 5E Model was developed by one of the leading names of the BSCS (Biological Science Curriculum Study) project, Rodger Bybee, and used in applications aimed at this project. The 5E Model grounds on the Constructivist Approach and the Model of Learning Ring. There is a good deal of "E" release in the literature. These are encountered as 3E, 4E, 5E, 7E etc., however, this study analyses the 5E Model. The 5E Model is consisted of the grades of Engage, Explore, Explain, Elaborate, Evaluate.

Keywords: Constructivist Approach, 5E Model, Physics Education and Teaching.

Resumen

En este trabajo, los estudios sobre el modelo 5E, que se fundamenta en el enfoque constructivista en los niveles educativos en el mundo y Turquía, además se utiliza como un modelo educativo y sus propiedades fueron analizados y la información fue presentada al respecto de este modelo. En el estudio, que se realizó de acuerdo con el método de análisis descriptivo, en esta investigación, sobre todo los trabajos, tesis en revistas indexadas en bases de datos como el centro de exploración Tesis de la Junta de Educación Superior, Ebsco Host, Science Direct, Taylor y Francis y la Red de Ciencia, etc y la literatura fueron analizadas en una perspectiva amplia. Las disertaciones, documentos obtenidos como resultado de la exploración se analizaron mediante adoptando los grados de objetivo, la conclusión y la educación en consideración. El modelo 5E fue desarrollado por uno de los principales nombres de la BSCS (Estudio Currículo de Ciencias Biológicas) del proyecto, Rodger Bybee, y se utiliza en aplicaciones destinadas a este proyecto. Los terrenos del Modelo 5E en el Enfoque Constructivista y el Modelo de Aprendizaje Anillo. Hay una buena parte de "E", liberación en la literatura. Éstos se encuentran como 7E 3E, 4E, 5E, etc., sin embargo, este estudio analiza el Modelo 5E. El modelo 5E está constituido por los grados de Envolver, Explorar, Explicar, Elaborar, Evaluar.

Palabras clave: Enfoque Constructivista, Modelo 5E, Educación Física y Enseñanza.

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I. INTRODUCTION

A lot of researches were made in the area of learning theory and constructivist approach. Researches such as Jean Paiget, Eleanari Duckwath, George Hein, and Howard Gardner get the bottom of them. Biological Science Curriculum Study (BSCS) Team of which group leader is Rodger Bybee improved a learning model according to constructivist thinking named 5E. Bybee worked with the other educational researchers to develop 5E Model [1].

The BSCS 5E Model is the most effective way of engaging students in learning. Developed in the 1980s, the BSCS 5E instructional model is a hallmark of these programs. First it is provided that students are engaged in the concepts through a short activity or relevant discussion. Next, students explore the concepts with the others by developing a common set of experiences. In the Explain, the teacher guides the students to develop an explanation for the concepts they have been exploring. In the Elaborate, the students extend their understanding or apply what they have learned in a new setting. In the Evaluate, the students and the teacher have an opportunity to evaluate the students' understanding of the concepts [2].

The 5E instructional model is based on a constructivist view. Because this model of learning is important, we summarize it before introducing the different phases of the 5E model. Constructivism is a dynamic and interactive

conception of human learning. Students redefine, reorganize, elaborate, and change their initial concepts through interactions among the environment, classroom activities and experiences, and other individuals. Learning individuals interpret objects and phenomena and internalize the interpretation in terms of their current concepts similar to the experiences being presented or encountered. In other words, changing and improving conceptions often require challenging the current conceptions and showing them to be inadequate. From a science teachers point of view the most important and psychological problem is to avoid leaving students alone an overall sense of inadequacy. If this occurs, educators have encouraged psychological problems.

If a current conception is challenged, there must be opportunity, in the form of time and experiences, to reconstruct a more adequate conception than the original one. In short, the students' construction of knowledge can be assisted by using sequences of lessons designed to challenge current concepts in order to provide opportunities for reconstruction of concept by themselves. This is one important justification for the 5E model and for other learning cycles [3].

What may be relevant to science and technology education today may become obsolete tomorrow due to constant technological advancement. Students need to develop skills to help them benefit from change rather than be put disadvantaged by it. Students need to think convergently and divergently to investigate challenges and problems as well as to think in complex and creative ways. These skills are higher-order thinking skills sometimes known as critical thinking skills. Although the age of students needs to be considered, Wilks has shown that higher-order thinking can and should be taught to students of all ages. In most primary schools, only lower levels of thinking are taught such as knowledge, comprehension and application. Students are encouraged to develop their memory, but not thinking skills. Higher levels of thinking include analysis, synthesis and evaluation. Learning experiences focus around these levels develops skills in problem solving, inferring, and estimating, predicting, generalizing and creative thinking. The development of higher-order thinking skills can benefit all students including younger students because they are encouraged to ask questions, answer them intelligently and share their ideas with others A constructivist view of teaching and learning incorporates higher-order thinking skills because it encourages exploration, inquiry and direct experience with materials and information and, in order to uncover students' preconceptions, students are encouraged to share experiences with others

Constructivism is seen as an orientation towards teaching and learning, a way of viewing how teaching and learning occur or simply a way of thinking about learning. Teachers do not view constructivism as a view of teaching and learning that can be followed to implement a teaching program. Nevertheless, it has been shown that constructivist theory can be implemented through many different teaching models or designs, one of these being the Five Es. The Five Es is a teaching model, based on Piagetian theory, which can be used to implement an implicit constructivist (more specifically neo-Piagetian, human or social-constructivist) view of teaching and learning. It is built around a structured sequence and designed as a tangible and practical way for teachers to implement constructivist theory. It purposefully promotes experiential learning by motivating and interesting students, as they are encouraged to engage in higher-order thinking. This is not to say that by following such a model, students will become intrinsically interested in the content presented and therefore motivated to construct meaning for themselves so that they will be able critically analyse and incorporate new views and different perspectives. Rather, the model provides a tangible referent for teachers to scaffold their developing expertise in structuring a learning environment that will facilitate students' interaction with a learning context in a critical, reflective and analytical way. The Five Es, as such, is an aid or organiser for the teacher to structure and sequence potential learning experiences in a systematic and synergistic way consistent with a constructivist view of teaching and learning. In itself, the Five Es is not an essential part of student learning. The Five Es is a model, scaffold or framework for the teacher [4, 18].

Researchers have offered alternative strategies to promote meaningful learning in science [5].

II. METHOD AND MATERIAL

Datas related with this research are the products of literature scanning made for postgraduate disquisition. Different ways were used to get data (continual publications, disquisition scanning service, other internet scanning services, books, journal…).

A. Findings

In the first part of disquisition, there are data related with learning models, 5E Model and its characteristics and also method used. It is deduced and made suggestions according to data got at the end of research.

B. 5E Model

The BSCS approach to the 5E Model is credited to Roger Bybee who developed the 5E model which will be used in the Applications of Research & Model Inquiry Lessons section of EJSE. Bybee's 5E model is as follows: Probably one of the earliest and foremost supporters of the Learning Cycle was the SCIS (Science Curriculum Improvement Study) program which adapted it and included it in its science curriculum. Although there are several "E" versions (*e.g.* 3E, 4 E, 5E, and other modifications) the basic premise is that children have an experience with the phenomena in the learning of the concept/topic [6].

When implementations of Constructivist approach are examined, some operators transformed three staggered circle model into five staggered circle model. This is 5E

Model. This model consists of Engage, Explore, Explain, Elaborate, Evaluate Phases [16]. On psychologic basis, 5E Model is based on structuring in mind theory [7].

Constructivist Approach based on the 5E Model is an established planning method in science education and is consistent with contemporary theories about how individuals learn. It is easy to learn and useful in creating opportunities to learn science. You can think of the learning cycle model as having five parts, though these parts are not discrete or linear.

Prior knowledge is an important determinant of learning and has been studied extensively in science education. From misconception research, there is widespread agreement that learners construct concepts from prior knowledge [8].

See Fig. 1, 5E Model and its phases according to the researcher Fig. 1 [9].

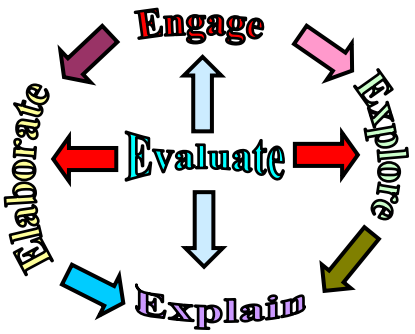

FIGURE 1. 5E model and its phases [9].

C. Why 5E Model in Physics Education?

The 5E encompasses the following: Principles Engagement taps student's prior knowledge about a physics concept, Exploration gives students the chance to work with physics concepts in a "hands-on" format. Following the Exploration Phase is the Explanation phase, where the teacher and/or students explain the concept in greater detail, introducing students to relevant physics vocabulary. In the Extension phase of the physics lesson, the teacher facilitates deeper or broader understanding of the lesson. Often this phase involves activities that direct students for applying their knowledge to the new situations. Finally, the teachers can assess student understanding of the physics lesson through some type of assessment or Evaluation.

The 5E Model approach can result in:

1. Greater achievement in physics,
2. Better retention of concepts,
3. Improved attitudes towards physics,
4. Improved attitudes towards physics learning,
5. Improved reasoning ability, and
6. Superior process skills [10].

III. PHASES OF 5E MODEL

5E Model is implemented in five phases. They are Engage, Explore, Explain, Elaborate, Evaluation. Presentation of 5E model formed by a researcher is showed in Fig. 2. 5E learning model proposed by the researcher are presented the Fig. 3 [11].

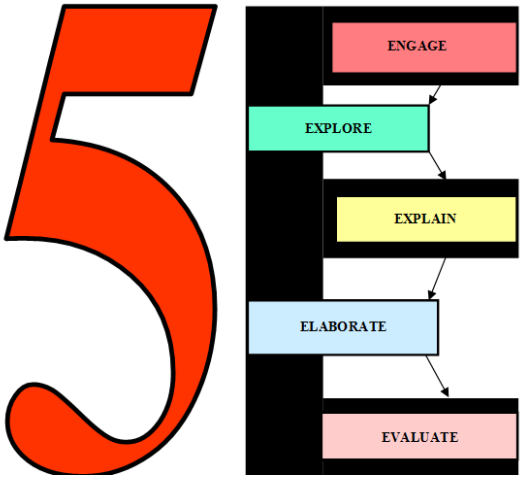

FIGURE 2. 5E model and its phases according to the researcher [11].

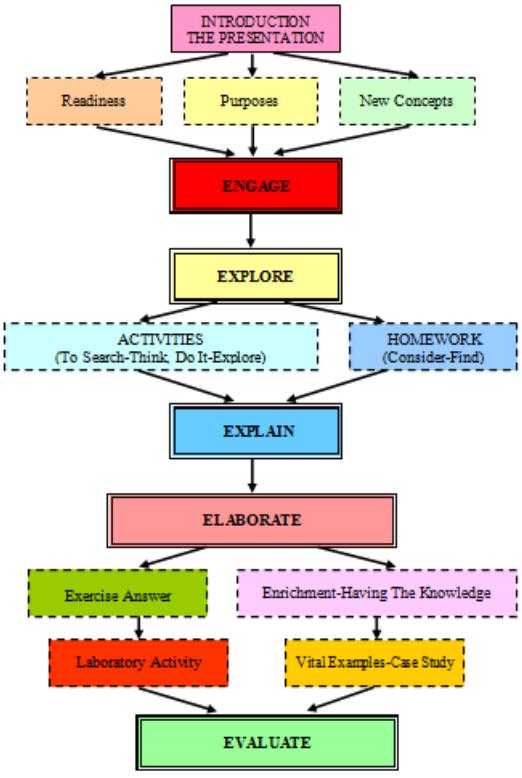

FIGURE 3. 5E teaching model designed by researcher [11].

A. Engage Phase

FIGURE 4. 5E model engage phase for the image [11].

In the first phase, you enable the student to engage in the learning task. The student mentally focuses on a problem, situation, or event. The activities of this phase should have connections with the past and the future activities. The connections depend on the learning task and the different dimensions of scientific literacy; they may be conceptual, procedural, or behavioral.

Asking a question, defining a problem, and showing a discrepant event are all the ways for enabling students to engage and focus them on the instructional task. The teacher's role is to present the situation and identify the instructional task. Moreover the teacher sets the rules and procedures for establishing the task.

A successful engagement results in students being puzzled and actively motivated in the learning activity. Here we are using the activity both in the constructivist and behavioral sense-that is, students are mentally and physically active; in other words, they have a "minds-on, hands-on" experience. If we combine the external events with the basic needs and interests of the students, instruction contributes to successful learning [3, 12, 13].

As synthesized by Berland and Reiser educators and educational researchers foster student engagement in scientific argumentation so they will articulate their ideas, make sense of complex phenomenon, and engage in the persuasive discourse of science [15].

B. Explore Phase

FIGURE 5. 5E model explore phase for the image [11].

Once you have engaged the students' interest in ideas, students need time to explore these ideas. You can specifically design exploration activities so that students in the class have common, concrete experiences that begin building concepts, processes, and skills. To use Piagetian terms, engagement brings about disequilibrium, while exploration initiates the process of equilibration. Some of the key words used to describe the type of activities used in this phase are concrete and hands-on. Courseware can be used in the phase, but it should be carefully designed to assist the initial process of conceptual reconstruction.

The aim of exploration activities is to establish experiences that a teacher can use later to formally introduce a concept, process, or skill. During this the activity, the students have time in which they explore objects, events, or situations.

As a result of dear mental and physical involvement in the exploration activity, students will be able to establish relationships, observe patterns, identify variables, and question events.

The teacher's role in the exploration phase is only as a facilitator or a coach. It is only the teacher giving who always initiates the activity, but later on and allows students the time and opportunity to investigate objects, materials, and situations based on each student's own concepts about phenomena. If called upon, the teacher may coach or guide students through questions, suggesting avenues of activity or thought, and hints that may avoid frustration and begin the process of mental reconstruction. Use of concrete materials and experiences is essential. However, it is important to remember that the teacher's role is subordinate to the students' activity. The exploration phase is an excellent time to use cooperative learning [3, 12, 13].

C. Explain Phase

The word explanation means the act or process in which concepts, processes, or skills become plain, comprehensible, and clear. The process of explanation provides the students and teacher with a common use of terms relative to the learning task. In this phase, the teacher directs the attention of student specific aspects of the engagement and exploration experiences. First, students are asked to give their explanations. Second, teacher introduces scientific or technological explanations in a direct and formal manner. Explanations are the ways of ordering the exploratory experiences. The teacher should base the initial part of this phase on students' explanations and clearly connect the explanations to experiences in the engagement and exploration phases of the instructional model. The key to this phase is to present scientific concepts, processes, or skills in a simple, clear, and direct manner, and move to the next phase. You should not equate telling learning. The explanation phase can be relatively short because the next phase allows time for restructuring and extends this formal introduction to the concepts, processes, and skills.

The explanation phase can be teacher, textbook or technology-directed. Teachers have a variety of tech-request and strategies at their disposal. Educators commonly use oral explanations, but there are other strategies, such as reading, video, film, and educational Courseware. This phase continues the process of cognitive construction and provides scientific words for explanations. In the end,

students should be able to explain exploratory experiences using common scientific terms. Students will not immediately express and apply the explanations-learning takes time. Students need time and experience to establish and expand concepts, Processes, and skills. For a summary of the explanation phase, see Fig. 6 [3, 12, 13].

FIGURE 6. 5E model explain phase for the image [11].

New opportunities to conduct compelling comparisons and track progress of individuals call for new research methods [14].

D. Elaborate Phase

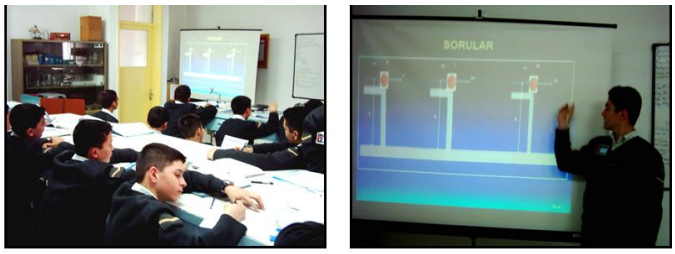

FIGURE 7. 5E model elaborate phase for the image [11].

Once students begin developing an explanation of their Reaming tasks, it is important to involve students in further experiences that extend or clarify the concepts, processes, or skills. The word explanation means the act or process in which concepts, processes, or skills become plain, comprehensible, and clear. The process of explanation provides the students and teacher with a common use of terms relative to the learning task. In some cases, students may still have misconceptions, or they may only understand a concept in terms of the exploratory experience. Elaboration activities provide further time and experiences that contribute to learning.

During the elaboration phase, students engage in discussions and information-seeking activities. The groups' goal is to identify and execute a small number of promising approaches to the task. During the group discussion, students present and defend their approaches to the instructional task. This discussion results in better definition and gathering of information that is necessary for successful completion of the task. The teaching cycle is not closed to the information from the outside. Students get information from each other, the teacher, printed materials, experts, electronic databases, and experiments they conduct. This is called the information base. As a result of participation in the group's discussion, individual students are able to elaborate upon the conception of the tasks, information bases, and possible strategies for its completion.

Interactions within student groups are an application of Vygotsky's psychology to the teaching model. Group discussions and cooperative learning situations provide opportunities for students to express their understanding of the subject and receive feedback from others who are close to their own level of understanding.

The phase is also an opportunity to involve students in new situations and problems that require the application of identical or similar explanations. Fig. 7 is a summary of the elaboration phase of the teaching model [3, 12].

E. Evaluate Phase

FIGURE 8. 5E model evaluate phase for the image [11].

At some point, students should receive feedback on their achievements. Informal assessment can be made in only the beginning of the teaching sequence. However the teacher can complete a formal assessment after the elaboration phase. As a practical educational matter, teachers must assess student learning. This is the phase in which teachers administer tests or performance activities to determine each student's understanding. This is also an important opportunity for the students to use the skills they have acquired and evaluate their own understanding. In addition, one justification for such a model lies in its providing adequate opportunities for all students to learn science.

The 5E instructional model is aligned with many processes involved in scientific inquiry. In science, the methods of scientific inquiry are an excellent means for students to evaluate their explanations. These methods are, after all, congruent with science. How well do student explanations stand up to review by peers and teachers? Is there need to reform ideas based on experience?

FIGURE 9. 5E model and its phases used in the researcher [11, 17].

Fig. 9, summarizes the evaluation phase. Fig. 9 provides additional details about what the teacher and the student do at different stages of the instructional model. We have provided descriptions of the methods and the activities that are both consistent and inconsistent with this model [3, 12, 13].

IV. RESULTS AND SUGGESTIONS

Of late years, until especially 1995, while curriculum has been renewed in many states of Canada, Australia, Ireland and Germany; continuous sweeping changes in Malaysia have attracted attention. Turkey is one of the countries affected from this development in last fifteen years. Changes made in science curriculum are the most striking instance of this. It takes attention that there are a lot of activities prepared according to constructivist approach in curriculum renewed in Turkey and other countries. Activities prepared according to constructivist approach and 5E Model is implemented in science curriculum prepared in Turkey and science books written according to this curriculum. Besides, Ministry of Education has published these activities in its web page. This study is very important in this regard, too. Some suggestions inferred thanks to results of research are given below.

According to 5E Model, While teaching a subject, giving examples from real world and wanting students to give examples similar to these the teachers given help students both research and link between real world and the subject. When the students have active roles in their learning, they learn and use the knowledge they have learned in the real world more easily. These make students more eager to science lessons to which they are usually reluctant.

When the subject is taught according to 5E Model, students use technological equipments more effectively. Using computer, internet and other technological equipments of students increases the effectiveness of this approach. In the implementation of 5E Model, Computers and computer-aided programs have been used. It is concluded that using computer is very effective for helping students understand the subject more perfectly. Using the computer in the learning atmosphere help they reach their goals more early.

Research related to 5E model and results of research show that 5E Model is a model which increases desire of researching, satisfies expectation of students, includes activities helping students have active roles in their learning. Because of this, Ministry of education should use this model in the curriculums which will be prepared.

According to result of this research; 5E Model is an approach that students have an active role in their learning. Besides, it is taken up seriously by them and it is thought to be an effective method. If teachers are trained before they begin to work, they will have an idea about characteristics and implementation of this model so they will have opportunities for implementing this method in their lessons.

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