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Evaluation of Experiments Conducted about 5E Learning Cycle Model and Determination of the Problems Encountered*

Murat Demirbaş[1] and Hüseyin Miraç Pektaş[2]

[1,2] *Kırıkkale University Education Faculty, Kırıkkale, Turkey*

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ABSTRACT

It is clear that the current Science and Technology curriculum in Turkey is based on the constructivism. It is known that it is teachers who put Science and Technology curricula into practice in schools; therefore, it is essential that they should be aware of new approaches to and theories of learning and teaching. Furthermore, it is believed that Science and Technology classes can best be carried out in laboratories. In this respect, the purpose of this study is to evaluate certain laboratory experiments conducted in accordance with the 5E learning cycle model. First, 40 primary school teaching students' reports were chosen out of a total of 60 primary school teaching students' reports. Afterwards, the 40 primary school teaching students who had written these reports were provided with an interview form. An analysis of the experiment reports suggested that the students had some deficiencies. Finally, some recommendations were made to overcome these deficiencies.

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Keywords:
5E Learning Cycle Model, Laboratory Experiments, Primary School Teaching Students, Science Education, Science Laboratory.

Introduction

The laboratory method refers to a teaching method by which students acquire basic scientific information by conducting experiments on their own that will verify such information (Nakiboğlu and Sarıkaya, 1999; Özmen, 2004). In other words, the laboratory method is a way of experiential learning in which students learn Science and Technology subjects individually or in small groups in laboratories or special classrooms (Yaşar et al., 1998). Laboratory practices enable students to do research, to solve problems, to use their manipulative skills and to develop their communicative skills, thus making learned concepts and the relationship between the concepts more meaningful and permanent.

Moreover, laboratory practices enable students to develop a positive attitude to science and play a role in their choosing a science-related profession (Hofstein and Lunetta, 2004). The use of laboratories and the extent to which the objectives are fulfilled are influenced by students' attitude towards laboratories, the number of students, teacher (instructors)- student interaction, laboratory textbooks, physical conditions of laboratories and approaches used throughout laboratory instruction (Freedman, 1997). In his "Constructivism: The Implications for Laboratory Work", Shiland (1999) explains what a laboratory environment should be like in order to enhance students' cognitive skills as follows: 1. Students should

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[1] Corresponding author's address: Kırıkkale University Education Faculty, Kırıkkale, Turkey
Telephone: 03183574242
Fax: 03183572487
e-mail: muratde71@hotmail.com
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determine relevant variables on their own, 2. They should design the procedures for research on their own, 3. They should plot tables on their own, 4. They should carry on their research in accordance with the standard research methodology, 5. Students should identify and eliminate the sources of their mistakes on their own, 6. Laboratory work should go back to the beginning and remind students about their misconceptions, 7. Students should provide predictions and explanations, 8. Laboratory solution should lead to another uncertain problem, 9. Students should be allowed to discuss their predictions and explanations before the experiment and their results after the experiment, and 10. Students should be provided with the opportunity for post-experiment practices. All these suggest that current laboratory practices should be based on constructivism.

Today many science instructors and educational researchers maintain that constructivism is a significant strategy and that those concerned should be encouraged to use it in the educational process (Hançer and Yalçın, 2007). Constructivism emphasizes that each learner constructs learning individually, that students do not take in information in the same way and that one's introductory information, personal traits and learning environment are influential in learning (Özmen, 2004). Constructivism has had profound influences on science education. Bybee's 5E learning cycle model is one of the science education models that are based on constructivism (Keser, 2003). Research has suggested that the 5E learning cycle model enhances students' achievement (Patlı, 1998; Ünal, 2003; Küçükyılmaz, 2003; Bayar, 2005; Özsevgeç, 2006; Özsevgeç et al., 2006; Yılmaz and Çavaş, 2006; Sağlam, 2006; Saygın et al., 2006; Ergin et al., 2007).

In his "Constructivism Examined", Fox (2001) examined constructivism as a promising approach to learning and education. He stressed that teachers should avoid a direct information transfer when they want to recognize their students' natural learning capacities, that they should not neglect the fact that old information has an influence on new information, as emphasized all the time, and that learning in this way will not pose a problem to either teachers or the teaching process. In another study "Three Views of Fairness in a School-Based Assessment Scheme of Practical Work in Biology", Yung (2001) reported that teachers suffered from a lack of experience in methods efficient in evaluating how well students could understand and perform in science laboratories.

The content of science generally involves abstract building stones, which makes it an obligation for the educational process to be carried out through activities based on experiential learning. In this respect, laboratories are an important component of education where students are able to gain experiences. Conventional approaches to learning have been replaced by constructivism, both in the classroom and laboratories. Accordingly, the educational/instructional environment should be designed in league with constructivism.

When the studies conducted on teachers and teacher candidates are reviewed, Kavas and Bugay (2009) determined the issues that teacher candidates face in the pre-service period. In their study conducted on 115 teacher candidates, they suggested that necessary changes that will help students put their knowledge into application be made. Furthermore, the study conducted by Çetin (2008) investigated the self-efficacy beliefs of the students of classroom teaching during science teaching class and indicated that there was not any change observed at the end of the process. This does not appear to be a desired situation. In another study, Özsevgeç (2006) developed materials on the subject of force and motion taking 5E into consideration, taught students using these materials, and observed an increase in students' scores in success and attitudes in the process of empirical research. Geçer and Özel (2012), on the other hand, determined the issues that science and technology teachers face in the teaching context. They indicated that the teachers faced issues in crowded classrooms and the use of laboratory context.

When the studies conducted are reviewed, it is observed it is of utmost importance that teacher candidates, when they become teachers, can conduct experiments based on the constructivist approach and develop materials accordingly. A teacher candidate that knows what to do at each phase of the 5E model will be able to create a positive classroom atmosphere and teach in line with the constructivist approach.

Problem of Research

It is teachers who put Science and Technology curricula into practice in schools; therefore, it is essential that they should be trained as individuals with contemporary knowledge, skills and attitudes and that they should be aware of new approaches to and theories of learning and teaching (Özmen, 2004). In this respect, the purpose of this study is to evaluate certain laboratory experiments conducted in accordance with the 5E learning cycle model.

The present study is based on the following problem statements:

1. To what extent are primary school teaching students able to write experiment reports in accordance with the 5E learning cycle model?
2. What problems do primary school teaching students experience in the process of designing experiment reports in accordance with the 5E learning cycle model?

Methodology

General Background of Research

The present paper is a case study, one of the qualitative research models. The objective of a qualitative study is to reveal the depth of the descriptions and meanings. Therefore, it is argued that it is better to select a smaller group to work in a detailed way than working with larger groups in a superficial manner (Çepni, 2005; Büyüköztürk et al., 2008; Ekiz, 2009).

Sample of Research

The study was carried out on the basis of criterion sampling, a method of purposive sampling. The principle of criterion sampling is to study all the situations that meet a series of pre-specified criteria. Researchers could either compose their own criteria or use pre-specified ones (Yıldırım and Şimşek, 2008).

The primary criterion for being included in the population of the present study was to be a second grade university student taking the course "Science and Technology Laboratory Applications-II". To meet the criterion, the study was conducted on the experiment reports prepared by a total of 40 second grade primary school teaching students, selected out of 60 ones, who studied primary school teaching at the Faculty of Education, Kırıkkale University in Turkey. The data were collected via the forms regarding the interviews conducted with the same students.

Instrument and Procedures

The purpose of the study is to evaluate student activities concerning the 5E learning cycle model. An assessment was made of the experiment reports prepared by the students in accordance with the 5E learning cycle model within the scope of the course "Science and Technology Laboratory Applications-II (STLA-II)". In the theoretical part of the course, the students were provided information as to constructivism, the 5E learning cycle model and writing experiment reports suitable for the model. Furthermore, they were presented with sample experiment reports which had been prepared in accordance with the 5E learning cycle model. In this way, an attempt was made to enable them to improve their abilities to write experiment reports according to the 5E learning cycle model. Within the scope of the course, the students were made to work in groups of 5 or 6 and allowed to choose their coworkers. Then, the units included in the Science and Technology curriculum for the 4th and 5th grade primary school students were divvied between the groups. Finally, the groups were asked to design experiments for these units, which are presented in Table 1.

Table 1. Units and experiments on the subjects included in the units

UNIT 1	***LET'S SOLVE THE MYSTERY OF OUR BODY***	***UNIT 5***	***THE WORLD: OUR PLANET***
Experiments	What shapes our body? How do we breathe? You can devise a stethoscope. Let's make a circulation model. The poison in a cigarette.	Experiments	The shape of the world Erosion The solution to Water Pollution: Refining. The night and day. The phases of the moon.
UNIT 2	***INTRODUCTION TO MATTER***	***UNIT 6***	***LET'S WANDER AROUND AND GET TO KNOW THE WORLD OF LIVING CREATURES***
Experiments	Liquids and gases have mass, too. Change of state. Heat exchange. Self-inflatable balloon. While the water is evaporating.	Experiments	The growth of beard mold. Let's make some colorful clove. Bacteria. Microscopic creatures in water. Yeast fungus.
UNIT 3	***FORCES AND MOTION***	***UNIT 7***	***ELECTRICITY IN OUR LIVES***
Experiments	Let's decompose mixed substances. Forces and speed. Which one falls down more slowly? Does forces change the shape of objects? Introduction to dynamometer.	Experiments	My own circuit (building a simple electrical circuit) The brightness of bulbs. The way bulbs give light. What are conductors and non-conductors? An analysis of a dry cell.
UNIT 4	***LIGHT AND SOUND***		
Experiments	Sound energy. How does light radiate? Umbra and penumbra. Different objects, different sounds. Does sound radiate in space?		

The students were provided with textbooks on experiments that they could use to get theoretical information about the subjects (Bingham, 2001; Bozkurt et al., 2008; Çepni et al., 2007a; Çepni et al., 2007b). The experiment reports the students had prepared were evaluated through a scale devised beforehand. The data on the first sub-problem of the study (To what extent are primary school teaching students able to write experiment reports in accordance with the 5E learning cycle model?) were assessed by means of the "The Scale for the Evaluation of Experiment Reports Prepared in Accordance with the 5E Learning Cycle Model" (Appendix 1). While the scale was designed, the stages involved in the 5E learning cycle model were identified and a review of literature (Başkan et al., 2007; Bozdoğan and Altunçekiç, 2007; Metin and Özmen, 2009) was conducted.

Data Analysis

Learned opinion was received as to the content and face validity of the checklist. The content analysis of the checklist was conducted using the four stages specified by Yıldırım and Şimşek (2008). The stages are as follows:

Data coding. It is possible to come up with a code list before data are collected when research is based on a theory or conceptual framework. The list may include either only themes or concepts that will fall under each theme as well. In such cases, data are collected in an easier way, for there is already a framework for data analysis.

Identification of themes. The primary issue in this stage is internal and external consistency. During the process of data coding for designing experiments and writing reports in accordance with the 5E learning cycle model, the dimensions were arranged in a way that would ensure coherence with the sub-items. In addition, great care was taken to make sure that these dimensions would involve students' ability to design and write about experiments in accordance with the 5E learning cycle model. The researchers consulted domain experts about the development of the measurement instrument and finalized the content on the basis of their opinions so that the thematic coding, which was done with consideration into internal and external consistency respectively, could significantly reflect all the skills and be valid.

Arrangement and Identification of Data by Codes and Themes

In this stage, the researchers identified and grouped the data obtained from the first two stages into an assessment scale according to certain standards.

The reliability of the study. The data collected through the study were evaluated by two instructors separately. The issues that include agreements and disagreements were discussed. Miles and Huberman's (1994) formula was used to calculate the reliability of the study.

Reliability = Number of Agreements / (Number of Agreements + Number of Disagreements)

The reliability of the study was determined as 0.90.

Identification and Interpretation of Findings

The checklist was composed in a way that would enable it to check and assess the reports on the activities to be carried out by the population. While grading the control list, the researchers studied the reports prepared by the students and circled one of the three alternatives for each statement, namely "Unacceptable", "Partly Acceptable" and "Acceptable". The alternatives were awarded 0 (Zero) point, 1 (one) point and 2 (two) points respectively. These types of evaluations are also to be made in similar studies (Saka and Akdeniz, 2006; Anıl and Küçüközer, 2010; Bozdoğan and Demirbaş, 2009).

The checklist consisted of 20 questions in five main headings. The first heading was "Engagement", which contained 4 statements. The statements were intended to test the students' skills in satisfying the requirements of engagement, the first stage of the 5E learning cycle model. The second heading was "Exploration", which was comprised of 4 statements. The statements were intended to test the students' skills in satisfying the requirements of exploration, the second stage of the 5E learning cycle model. The third heading was "Explanation", which was comprised of 4 statements. The statements were intended to test the students' skills in satisfying the requirements of explanation, the third stage of the 5E learning cycle model. The next heading was "Elaboration", which was comprised of 4 statements. The statements were intended to test the students' skills in satisfying the requirements of elaboration, the fourth stage of the 5E learning cycle model. The last heading was "Evaluation", which was comprised of 4 statements. The statements were intended to test the students' skills in satisfying the requirements of evaluation, the last stage of the 5E learning cycle model.

Afterwards, in the second part of the study, the students were presented with an interview form that contained several open-ended questions. The purpose was to identify the problems experienced by the primary school teaching students while designing the experiment reports in accordance with the 5E learning cycle model, which constituted the data for the second sub-problem. The questions were as follows:

1. In which stage of the 5E learning cycle model do you have most difficulty, explain why?
2. Do you think that the 5E learning cycle model can be applied to all science subjects, explain why?
3. To what extent do you think the 5E learning cycle model can be applied into the laboratory environment?
4. Would you like to apply the 5E learning cycle model to your classes when you start teaching, explain why?

The questions were formed by the researchers following a review of literature and discussions with subject matter experts. Focus-group interviews were conducted so as to identify the problems experienced by the students while designing the experiment reports in accordance with the 5E learning cycle model. The data were analyzed through a content analysis, a qualitative data analysis method. The objective of a content

analysis is to identify the existence of certain words or notions in a set that is comprised of a text or texts. Researchers determine and analyze the existence, meaning, and relationships of these words or notions, and draw conclusions from the message conveyed by the texts (Büyüköztürk et al., 2008). The reason for conducting a content analysis in the present study was to ensure an in-depth analysis of the problems experienced by the students while designing the experiment reports in accordance with the 5E learning cycle model and identification of the sources of these problems.

Results of Research

To what extent are students able to write experiment reports in accordance with the 5E learning cycle model?

The results of the data obtained from the experiment reports which were written by the students according to the 5 E learning cycle model were presented in Table 2.

Table 2. An evaluation of the science and technology laboratory reports prepared in accordance with the 5E learning cycle model

STAGES AND EVALUATION CRITERIA		Acceptable		Partly Acceptable		Unacceptable	
		%	f	%	f	%	f
ENGAGEMENT	1. Revision of the subjects covered in previous classes.	47.5	19	20.0	8	32.5	13
	2. Attracting the attention of students on the subject.	20.0	8	15.0	6	65.0	26
	3. Asking sample questions from daily life.	15.0	6	15.0	6	70.0	28
	4. Helping students propose different ideas through different questions.	37.5	15	12.5	5	50.0	20
EXPLORATION	5. Choosing those experiments that are related to the subject.	65.0	26	15.0	6	20.0	8
	6. Making sure that the results of experiments provide an answer to the questions formed by students in the stage of engagement.	55.0	22	20.0	8	25.0	10
	7. Making sure that questions encourage students to come up with new ideas to explain a particular phenomenon.	25.0	10	12.5	5	62.5	25
	8. Translating the information produced at the end of experiments into solutions.	37.5	15	05.0	2	57.5	23
EXPLANATION	9. Helping students replace former insufficient information with new information.	45.0	18	25.0	10	30.0	12
	10. Presenting the results of the stage of exploration in an orderly fashion.	67.5	27	20.0	8	12.5	5
	11. Providing sufficient explanation.	45.0	18	25.0	10	30.0	12
	12. Making sure that what students have already learned is reinforced at the end of experiments.	55.0	22	25.0	10	20.0	8
ELABORATION	13. Going through subjects from a different perspective.	45.0	18	25.0	10	30.0	12
	14. Incorporating new definitions and notions.	50.0	20	20.0	8	30.0	12
	15. Linking subjects with daily life.	70.0	28	10.0	4	20.0	8
	16. Providing a solution to another relevant problem.	57.5	23	12.5	5	30.0	12
EVALUATION	17. Using alternative evaluation techniques for the subjects learned.	75.0	30	07.5	3	17.5	7
	18. Making sure that questions cover the whole subject.	55.0	22	20.0	8	25.0	10
	19. Including those questions that will encourage students to do research.	50.0	20	25.0	10	25.0	10
	20. Making sure that questions are appropriate for the level of students.	37.5	15	25.0	10	37.5	15

A review of the findings on the first sub-problem of the study suggests that the students mostly had problems with engagement and exploration, the first two stages of the 5E learning cycle model.

To put it in a more detailed way, their data to the statements "attracting the attention of students on the subject", "asking sample questions from daily life" and "helping students propose different ideas through different questions", which were included in the stage of engagement, were found to be unacceptable.

In addition, their responses to the statements "making sure that questions encourage students to come up with new ideas to explain a particular phenomenon" and "translating the information produced at the end of experiments into solutions", which were included in the stage of exploration, were found to be unacceptable.

The following section includes the definitions of engagement and exploration as stages of the 5E learning cycle model and statements on the evaluation of the experiment reports of the students in reference to the definitions.

Engagement: Before attempting to learn about new ideas, people must be aware of their older ideas. For that reason, the first thing a teacher is supposed to do is to help students define what they already know about a particular subject. The class starts with an entertaining and intriguing introduction so that students can understand a problem of theirs or a phenomenon they observe. In this stage, certain questions are addressed to the students as to the reasons for a particular phenomenon. However, the stage does not involve any explanation or definitions concerning the notions, nor does it inform students about what they are going to see and learn about. What is important here is not to make students provide correct answers, but to encourage them to come up with novel ideas.

A sample unacceptable procedure for the stage:

S8: Hello guys! Today we will be working on electricity and build a simple electrical circuit together. Before we do that, let's talk about the subject for a while. What are open-circuit and closed-circuit? Following the question, the subject is covered.

A sample partly acceptable procedure for the stage:

S12: First of all, the students were encouraged to do some thinking through such questions as "What is respiration?" and "What is the respiratory system?". After they had presented their ideas, the following definition was provided: The respiratory system is a system that enables the carbon dioxide (CO_2) in the blood to be replaced with oxygen. Then, the following questions were addressed so as to make them a little more curious.

a) *How does breathing take place in human beings?*
b) *Why is respiration important to human beings?*
c) *What are the structures and organs that are responsible for breathing?*

A sample acceptable procedure for the stage:

S16: The teacher enters the classroom with a handful of pins, which are then scattered on the ground. In reference to the previous subject, the students are asked to comment on how to collect the pins without contacting them. To prompt them to come up with a proper way, they are reminded about the definitions of forces, contact forces and non-contact forces. In this way, a smooth introduction is made into magnets, a subject covered within the scope of non-contact forces. The students are asked to come up with a proper way to collect the pins scattered on the ground without contacting them. An attempt is made to lead their answers to the subject. Then, one of the students who have provided a correct answer (magnet) is made to go to the blackboard to perform his/her idea.

Exploration: In this stage, students come up with ideas to solve a problem or explain a phenomenon through collaboration and experiments or by working on a computer, video or library accompanied by their teacher. After they have been filtered by their teacher, these ideas are translated into skills and solutions. It is exploration that involves the greatest amount of student activity/participation.

A sample unacceptable procedure for the stage:

S32: On the basis of the intriguing activity carried out in the beginning, the students are informed that they will be working on magnets. The name of the experiment is presented, namely "Matters Affected by Magnets". Afterwards,

the students are shown the materials, which contain iron filing, sand, sawdust, coins, a magnet, a glass of water and paper, and asked to comment on what can be done with these materials.

A sample partly acceptable procedure for the stage:

S24 Experiment 1 (Sound Reflection): Let's put some cotton into the case with an aluminum scale and place a pocket watch on the cotton. Let's try to hear the ticks of the watch from the upper side of the aluminum case. Then, put the screen at an angle of 45° to the case and listen to the ticks. What are the implications of this experiment?

Implication: The ticks of the watch hit the screen, get reflected and reach the ears. In this way, we can hear the ticks. One can measure a particular distance making use of the ability of sound to be reflected. We call it echo when sound waves hit a surface, get reflected and heard again.

A sample acceptable procedure for the stage:

S2: Let's conduct some experiments to make a more clear distinction among solids, liquids and gases.

Experiment 1.A: Pour 200 ml of water into a 250-ml beaker. Drip a few drops of ink into the water.

Experiment 1.B: What do you observe in the water? Post-Experiment Questions: 1) How did the drops of ink behave? Result: 1) What quality of liquids can be concluded from the behavior of the drops of ink? 2) Would it have been possible to observe the same behavior if we had poured olive oil instead of ink into the water?

What are the problems experienced by the students while designing the experiment reports in accordance with the 5E learning cycle model? Findings on the sub-problem.

The findings on the second sub-problem are as follows.

The findings on the stage of the 5E learning cycle model the students had most difficulty in. The findings on the stage of the 5E learning cycle model the students had most difficulty in are presented in Table-3.

Table 3. The students' opinions as to the stage of the 5E learning cycle model they had most difficulty in

Statements on the stage of the 5E learning cycle model the students had most difficulty in	*f*
1. I found "engagement" to be the most difficult stage. I conducted intensive search in order to attract attention to the subject.	33
2. In "engagement", I had problems with asking questions from daily life, finding questions and creating questions. "	28
3. In "exploration", I had difficulty in finding and creating attention-grabbing experiments.	20
4. I cannot decide what level subjects I need to cover in "elaboration".	4

The students had most difficulty in engagement and exploration (Table-3). The findings on the two sub-problems are in parallel with each other, which means that the students could completely reflect the problems they had experienced on their reports.

Opinions as to the applicability of the 5E learning cycle model to all science subjects

The findings on the applicability of the 5E learning cycle model to all science subjects are presented in Table 4.

Table 4. Opinions as to the applicability of the 5E learning cycle model to all science subjects

Statements on the applicability of the 5E learning cycle model to all science subjects	*f*
1. It is easier to apply it to experiment-based subjects.	18
2. It cannot be applied to memorization-based subjects.	12
3. It cannot be applied to every subject in biology.	12
4. It can mainly be applied to physics subjects.	10
5. One can have problems with applying it to subjects that have a comprehensive content.	30

A total of 30 students noted that "one can have problems with applying it to subjects that have a comprehensive content" whereas another 18 stated that "it is easier to apply it to experiment-based subjects". On the other hand, 12 students argued that "it cannot be applied to memorization-based subjects" while another 12 maintained that "it cannot be applied to every subject in biology". Finally, 10 of the students believed that "it can mainly be applied to physics subjects". As can be concluded from their opinions, the students mainly do not believe that the 5E learning cycle model can be applied to all science subjects.

To what extent do you think the 5E learning cycle can be applied to the laboratory environment?

The students' opinions as to the extent to which the 5E learning cycle can be applied to the laboratory environment are presented in Table 5.

Table 5. Opinions as to the extent to which the 5E learning cycle can be applied to the laboratory environment

Statements on the extent to which the 5E learning cycle model can be applied to the laboratory environment	*f*
1. It is difficult to apply it to the laboratory environment, so it will take too much time to do so.	28
2. It might be difficult to control it in the laboratory environment.	17
3. The application of the model to the laboratory environment will attract the attention of students.	30
4. Teachers may have difficulty in applying the method.	13

A total of 30 students noted that "the application of the model to the laboratory environment will attract the attention of students" whereas another 28 stated that "it is difficult to apply it to the laboratory environment, so it will take too much time to do so". On the other hand, 17 students believed that "it might be difficult to control it in the laboratory environment" while 13 of them maintained that "teachers may have difficulty in applying the method". In general, most students (30) held that the application of the 5E learning cycle model to the laboratory environment will attract the attention of students.

Would you like to apply the 5E learning cycle model to your classes when you start teaching?

The students' opinions as to whether they would like to apply the 5E learning cycle model to their classes when they start teaching are presented in Table 6.

Table 6. The students' opinions as to whether they would like to apply the 5E learning cycle model to their classes when they start teaching

Statements on whether they would like to apply the 5E learning cycle model to their classes when they start teaching	*f*
1. I will apply it, for it attracts the attention of students.	22
2. I will often use the method in my classes, for it enables students to learn better.	26
3. I am planning to use it in my classes, but I am not in favor of applying it to the laboratory environment because it is difficult.	12
4. I am planning to frequently use it in my classes, for it is a very efficient method.	18
5. I will actively use the method in my classes if more hours are allocated to science classes.	27

Many students (27) stated that they would actively use the method in their classes if more hours were allocated to science classes. A total of 26 students noted that they would often use the method in their classes, for it enabled students to learn better while another 22 reported that they would apply it, for it attracted the attention of students. On the other hand, 18 of the students said that they were planning to frequently use it in their classes, for it was a very efficient method whereas another 12 reported that they were planning to use it in their classes, but they were not in favor of applying it to the laboratory environment because it was difficult.

Discussion and Conclusions

The results of the study, as well as interpretation for each result, are presented below.

1. First, the researchers studied the abilities of the students to write experiment reports in accordance with the 5E learning cycle model. The findings suggest that the students mostly had difficulty in engagement and exploration. It was observed in the stage of engagement that their responses to the statements "attracting the attention of students on the subject", "asking sample questions from daily life" and "helping students propose different ideas through different questions" were unacceptable. As for the stage of exploration, it was found that their responses to the statements "making sure that questions encourage students to come up with new ideas to explain a particular phenomenon" and "translating the information produced at the end of experiments into solutions" were unacceptable. The findings are compatible with those of Başkan, Alev and Atasoy (2007) and Metin and Özmen (2009). These problems probably result from the fact that the students had insufficient content knowledge about science and they could not fully understand what should be done in engagement and exploration. Therefore, students should be provided with further content knowledge about sciences and informed about the 5E learning cycle model in a more proper way.

2. In the second sub-problem, the students were asked to comment on the stage of the 5E learning cycle model that they had most difficulty in. The findings were in parallel with the ones found in the first sub-problem. At this point, they had difficulty in finding and creating questions. Furthermore, the students stated that they could not decide what level subjects to cover in the stage of elaboration. The finding is supported by that of Başkan, Alev and Atasoy (2007). The students experienced these problems probably as a result of not fully understanding the 5E learning cycle model. Research on learning has suggested that students significantly learn better and more permanently in science classes when they actively participate in experiments (Ergin, 2009). The 5E learning cycle model is believed to ensure a similar learning environment. The instructors should provide students with more examples of methods that can be used to attract the attention of students when they are explaining them the 5E learning cycle model.

3. In the next sub-problem, the students were asked to comment on the extent to which the 5E learning cycle model can be applied to all science subjects. The students noted that the model could be applied to

experiment-based subjects and thus physics subjects. On the other hand, they reported that it could not be applied to memorization-based subjects and thus biology subjects. Finally, the students stressed that one could have problems with applying the model to subjects with a comprehensive content. The study by Başkan, Alev and Atasoy (2007) yielded the same finding. The students' ideas indicate that they might fail to fully understand constructivist learning methods.

4. As for the next sub-problem, the students were asked to comment on the extent to which the 5E learning cycle model can be applied to the laboratory environment. On the whole, the students noted that it would take too much time, that it would be difficult to control it and that teachers might have difficulty in applying it. The findings suggest that the students possibly shy away from the laboratory environment, do not have necessary manipulative skills or are not able to use experiment materials in a proper way.

5. Lastly, the students were asked whether they would like to apply the 5E learning cycle model to their classes when they started teaching. On the whole, they reported that they were not in favor of applying it to the laboratory environment because it would be difficult and that they would actively use it if more hours were allocated to science classes. A review of their experiment reports shows that the biggest problem is students' failure to fully understand science subjects or their obligation to make much effort to understand them. Therefore, an attempt should be made in schools to make science classes more attractive to students, to associate them with daily life and hence enhance their achievements.

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Appendix 1: The scale for the evaluation of experiment reports prepared in accordance with the 5e learning cycle model

	STAGES AND EVALUATION CRITERIA	*Acceptable*		*Partly Acceptable*		*Unacceptable*	
		%	*f*	*%*	*f*	*%*	*f*
ENGAGEMENT	1. Revision of the subjects covered in previous classes.						
	2. Attracting the attention of students on the subject.						
	3. Asking sample questions from daily life.						
	4. Helping students propose different ideas through different questions.						
EXPLORATION	5. Choosing those experiments that are related to the subject.						
	6. Making sure that the results of experiments provide an answer to the questions formed by students in the stage of engagement.						
	7. Making sure that questions encourage students to come up with new ideas to explain a particular phenomenon.						
	8. Translating the information produced at the end of experiments into solutions.						
EXPLANATION	9. Helping students replace former insufficient information with new information.						
	10. Presenting the results of the stage of exploration in an orderly fashion.						
	11. Providing sufficient explanation.						
	12. Making sure that what students have already learned is reinforced at the end of experiments.						
ELABORATION	13. Going through subjects from a different perspective.						
	14. Incorporating new definitions and notions.						
	15. Linking subjects with daily life.						
	16. Providing a solution to another relevant problem.						
EVALUATION	17. Using alternative evaluation techniques for the subjects learned.						
	18. Making sure that questions cover the whole subject.						
	19. Including those questions that will encourage students to do research.						
	20. Making sure that questions are appropriate for the level of students.						