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HOW IS THE LEARNING ENVIRONMENT IN PHYSICS LESSON WITH USING 7E MODEL TEACHING ACTIVITIES

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Abstract:
The aim of this research is to reveal the results in the planning, implementation and evaluation of the process for learning environments to be designed in compliance with 7E learning cycle model in physics lesson. "Action research", which is a qualitative research pattern, is employed in this research in accordance with the aim of the research. The research was implemented at a public high school in Turkey. The research continued for twelve weeks. Two-hour class periods were included on a weekly basis. Study group of the implementation consists of 52 students attending to two different classrooms. The ages of students vary between 15 and 16. Triangulation method was employed in collection and evaluation of data in order to increase research reliability. Observation, interview and peer assessment were used in this study for process description. It is revealed from the observations that the majority of students perceived the lessons as more pleasing by virtue of the discussions in physics lesson.

Keywords: 7E model, physics education, action research

1. Introduction

Learning is related to a structural shift in cognition. It is related to automatic readjustment of critical moments. These changes are complex and non-linear. Furthermore, cognitive changes are result of interaction and self-learning systems.

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Learning occurs when conceptual structures are reinterpreted in the mind of learner as a result of internalization (assimilation) and adjustment of new information. It is not possible to internalize or assimilate information in a simple manner. Information is interpreted and organized with new acquisitions based on cognitive structures previously developed, and a new meaning is formulated on these (Fosnot, 2013). If students sense that the information in physics is not abstract and, contrarily it is directly associated with their life, then they learn science by feeling it owing to their increased interest in and attitude towards it. Such association may even facilitate their learning (Cepni, Ayas, Johnson and Turgut, 1997).

Inquiry and research-based teaching methods (discovery, exploration and inquiry research methods), which have been developed by taking the steps followed in scientific research process into account and conceptual change-based teaching methods (conceptual change texts, analogies, 5E and 7E) are rather prominent as compared to other teaching methods. More predominant employment of these methods than the others can achieve a better learning of physics lesson acquisitions and more organized conceptual structures and skills of students. (Acıslı 2010; Gurbuz 2012; Hırca 2008; Kanli 2007; Savas 2009 and Ozsevgec 2006).

Findings resulting from studies which employ 7E learning cycle model based on structural learning theory indicate that this learning model increases academic success level of students, improves their attitude towards science and allows for permanent conceptual development (Avcioglu, 2008; Cepni, San, Gokdere and Kucuk, 2001; Gurbuz, 2012; Kanli, 2007). Furthermore, conducted studies emphasize the effect of worksheets on the increased success in concept teaching (Budak, 2000; Kurt, 2002). Considering all of these, the question to which an answer is sought in the research comes to our minds: "*What are the results in the planning, implementation and evaluation of the process for learning environments to be designed in compliance with 7E learning cycle model in physics lesson?"*

1.1. Theoretical Framework

"7E Model" has been included in the literature when Eisenkraft (2003) expanded on BSCS 5E model, which is a widely preferred and recognized instructional models of today, by introducing two new phases on the first and final phases. The first phase in 5E model, which is the engage phase, has been preceded by an elicit phase in which students elicit prior information, and the final phase in the same model, which is the evaluate phase, has been followed by an extend phase while the phases in between remained the same.

Sahin (2014) intended for the determining to which extent the structural approach is included in the learning and teaching activities regarding Science lessons in the academic curricula of Faculties of Education based on opinions of students. Findings of research reveal that activities related to structural approach are included and used in teaching.

Carkıt (2013) addressed the evaluation of grammar teaching process from the perspective of structural approach at secondary schools. Practices of teachers during the course of process were comparatively examined based on genders and service durations of teachers. The majority of interviewed teachers mentioned that they engage students in study book activities after lecturing grammar subjects and having students take notes, and they stated that traditional lecture method and question-answer method were the most predominantly used methods while teaching grammar.

Yerdelen (2013) carried out his study with the purpose of researching the effect of 7E learning cycle, which has been improved in epistemological and metacognitive terms, on the success in physics lesson and epistemological understanding of high school students. As a result of the study, a significant difference to the favor of experimental group was observed in the mean epistemological understanding scores of students in experimental and control groups. Furthermore, it has been also determined that the traditional method is more effective in increasing the success levels of children, who demonstrate very low epistemological understanding, in physics, whereas 7E learning cycle which has been improved in metacognitive terms proves more useful to other students.

Gurbuz (2012) studied the effect of materials, which were developed in accordance with 7E learning model in science lesson at secondary school, on academic success of students and permanency. As a result of the research, it was observed that the materials prepared in accordance with 7E learning model increased their academic success and achieved conceptual permanency.

2. Methodology

Data obtained from the same environment by means of different measurement tools are recommended to be comparatively analyzed in order to detect the unique qualities of learning environment in a valid and reliable manner (Keser, 2003). In this context, it was deemed necessary to develop and employ multiple research techniques in addition to instruments thereof which are supported by interviews with students and direct observation of relevant environments so that an impartial critical view of the learning environment process can be achieved with a full and in-depth control. Therefore, multiple measurement tools are used in this research so as to ensure that teaching process is evaluated in the best possible manner.

"Action research", which is a qualitative research pattern, is employed in this research in accordance with the purpose of the research. According to Mills (2003), action research is a process of systematic inquiry that seeks to identify the manner in which teaching by will be delivered teachers, researchers, administrators, school counselors or other participants in teaching-learning environment and how students can achieve better learning. This method combines research and practice, thus facilitating the implementation of research results. Teachers conduct the activity itself or play an important role in action research. Teachers examine a problem or an action, which is identified through observation of teaching process, in a systematic and sequential way. Therefore, action research is also called "teacher research" (McNiff, Lomax and Whitehead, 2004).

In action research, data collection process takes place in a systematic way as well. Both qualitative and quantitative data collection methods can be employed (McMillan and Schumacher, 2010). Data collection methods in action research may vary depending on research questions, status of research and individual qualifications of researcher. In this scope, data may be collected with the help of methods that are based on experience, inquiry and examination. In experience-based methods, participatory observation, field notes, meeting minutes, observation etc. may be used as data collection tools based on active or passive participation of researcher in data collection process. Inquiry-based methods include structured, unstructured and semi-structured interviews, standard tests, questionnaires, attitude scales, control lists, self-assessment forms and similar data collection tools. In scope of examination-based methods, audio and video records, diaries, internet logs, e-mails, student products, maps, plans, archive records etc. may be used as data collection tools. By virtue of these, researcher finds the opportunity to use a suitable research method or integrating new research methods into the process in circumstances where researcher is incapable of providing adequate answers to research questions. Therefore, data which support each other are collected at different times and locations in an attempt to achieve data triangulation in action research (Kuzu, 2009).

2.1 Research design and study group

The research was implemented at a public high school in Turkey. The main criterion in the selection of this school is the fact that one of the researchers has been delivering service as a physics teacher for six years at the school. Besides, the physics laboratory at which the study was carried out had the necessary materials available. The support given by school administration to such academic researches has also played a major role in the selection of the school.

The research continued for twelve weeks. Two-hour class periods were included on a weekly basis. Magnetism unit was delivered at two different classrooms of 11th grade students. The prominent concepts in the subjects under electromagnetism unit of 11th grade physics curriculum are as follows:

- Magnetic pole;
- Magnetic field;
- Magnetic properties of substances;
- Magnetic permeability;
- Magnetic force;
- Magnetic flux;
- Magnetic induction, Faraday's and Lenz's Law.

In scope of this research, worksheets were prepared based on 7E model reported by Keser (2003) in the lesson teaching process according to the structural approach. The literature on particularly magnetism related to science teaching in accordance with structural learning theory was reviewed, and worksheets were prepared based on the evaluation of the results. Seven worksheets were prepared based on the number and quality of objectives and acquisitions and intensity of concept, all of which are specific to the scope of the subject. Worksheets were designed in the form of two sheets by using colorful and easily comprehensible images in two columns in horizontal order in order to allow for activities and sequence among phases to be easily understood. Furthermore, sentences were kept briefly with underlined or italic writing of important concepts. Study group of the implementation consists of 52 students attending to two different classrooms at a public high school in 2013-2014 academic year. The ages of students vary between 15 and 16. The study was carried out by dividing students in groups of five. Two groups, however, consisted of six students each. During the course of implementation, researcher-teacher toured among the groups and provided students with guidance, ensured that they discussed about the activity and questions.

2.2. Data Collection Tools

"Data source triangulation" method was employed in collection and evaluation of data in order to increase research reliability. Observation, interview and peer assessment were used in this study for process description.

2.2.1 Individual interview

Researchers conducted semi-structured evaluations in order to identify the process-related situations that were not observed and to collect data based on student opinions. Semi-structured interview is a data collection method based on qualitative research approach used to obtain same type of information from different individuals, in which researcher can obtain in-depth information on research subject, act with the flexibility of asking additional questions while adhering to previously developed interview form (McMillan and Schumacher, 2010). Semi-structured interview was opted in this research in order to determine parallelism or difference between the interviewees in respect to delivered information, to make comparisons accordingly while providing data for discovery.

"Process-related semi-structured interview form" (PRSSIF) was prepared for students to obtain data on to which extent structuralism-based elements have been actually implemented, the problems encountered during the course of program implementation, and recommendations. Prior to preparation of semi-structured interview form, the studies and documents in the literature were reviewed. This form has been designed in three sections and supported with probes in accordance with specialized academicians to seek answers to sub-problems (Appendix 1). The information on researchers and a brief introduction of the objective and reason of research are given in the first section of the form; the questions regarding evaluation of process by student in scope of the research objective are included in the second section while the questions with seek to reveal to which extent the worksheets are fit for purpose are in the third section.

6 out of 52 students in the study group were randomly chosen and individual interviews were conducted in the research. Interviews were made immediately following the completion of relevant teaching activity and were recorded in audio and video. Each interview lasted for approximately 40 minutes. After interviews, the records were transcribed into writing without any alteration in the meaning of opinions and thoughts and evaluated.

2.2.2 Observation

Observation can be expressed as one or multiple individual(s) observing and recording the occurrences in real life within framework of a plan (Raizen & Rossi, 1998). If individual(s) does not give verbal information on the research subject or have difficulty in explaining a situation, researchers develop and collect data based on what they see, hear and record by means of observation (McMillan and Schumacher, 2010). In this respect, weekly teaching activities were videotaped. Video records allowed for one of the researchers who is also a teacher to observe the activities thereafter, making an objective approach to classroom practices possible. Furthermore, it was also attempted to contribute to evaluation of different occurrences during the course of teaching process by different individuals and to enable them to express their opinions on the process in a concrete manner while increasing reliability by means of interaction within the classroom, and performance of teachers and students.

"Integrating Learning Environment Questionnaire" developed by Keser (2003) and "Structural Environment Observation Form for Chemistry Lesson" developed by Yasar and Sozbilir (2012) were reviewed and a new observation form was developed in accordance with the objective and structure of research in this study. A pilot study was carried out to determine any unforeseen circumstances excluded from expected occurrences by recording the learning environment to the extent possible. Following the practice, deficiencies about observation form were remedied and after certain readjustments, the observation form was finalized considering expert opinions.

Observation form includes blank sections in which observers may record their thoughts on the respective frequencies of behaviors expected from teacher and students as well as on activities themselves in the activities carried out in accordance with 7E model in the available learning environment. One observation form for implementation of each worksheet was used in the research.

2.2.3. Peer Assessment

It is known that carrying out teaching process based on smaller groups rather than the overall classroom facilitates achievement of lesson objectives based on the nature of lesson and subject. Active learning and personalized teaching methods are more efficiently used when wide classrooms are divided into smaller groups. Group study, which is organized based on interests, abilities, skills and perspectives of students as well as nature of activities, helps students with more efficiently engaging in learning and teachers with monitoring students more easily. By virtue of group studies, students learn to act in collaboration with each other and they are encouraged to solve problems and assume responsibilities together (Doganay and Karip, 2006). To this end, in-group peer and self-assessment form was developed in order to obtain opinions and thoughts of students on the subject or subjects delivered during the course of implementation process in the research.

In scope of the objectives of the lesson, the form to be used for peer and self-assessment conducted to ensure individual development of cognitive process skills and student participation within group are continuously followed, was adapted from high school physics course book (Kurnaz et. al, 2010). The validity of scope was ensured by receiving opinions from three specialized academicians and two physics teachers to this end. The form which consists of 24 items was prepared in 4-point Likert scale where always, usually, sometimes and never corresponded to (4), (3), (2) and (1), respectively. Students were explained how to fill in the form, which was filled out for seven times by different students within a group after application of each worksheet.

2.3. Data Analysis

2.3.1. Analysis of individual interviews

Interviews were recorded and transcribed into writing. Responses to questions in these transcriptions were classified based on similar or different meanings, and also exemplary quotations were directly reported without changing the meaning. It was primarily attempted to identify the mutual points of agreement or disagreement of individuals in the analysis of the interview data. Rather than predefining the categories, these were developed as a result of grouping these in accordance with the similarities or contrasts of student responses (Ozsevgeç, 2007).

It is recommended that, rather than verbatim quotation of all of the statements made by individuals during the interviews, researchers should omit their expressions and comments, and the information obtained should be adjusted subsequent to this stage in the analysis of interviews (Cohen & Manion, 1989). Cohen and Manion (1989) suggest that correlated expressions should be grouped into the same categories. Furthermore, it is believed that direct quotation of sentences as a verbatim reflection of thoughts of individuals would prove highly useful in the presentation of interviews.

2.3.2. Analysis of observations

As researcher is continuously involved in the process, a nested analysis of the data obtained from the observation forms both directly through the process and at the end of the process by examining camera records was conducted through two distinct approaches: qualitative and quantitative.

The process of teaching the unit based on seven worksheets was observed by researchers, and qualitative data were obtained by calculating the mean observation score for each item on the form. Scoring was based on factors such as number of repetition of a behavior based on its quality and contents, degree of participation, level of attention and actions that should be taken one time at minimum. Items with a mean score of 2 and higher were considered to be realized at the desired level (Ozsevgec, 2007). The notes written down by researchers during observations constituted the qualitative aspect of findings.

2.3.3. Analysis of peer assessment

For in-group peer assessments, total scores of items for 23 behaviors addressed on the form were calculated for 52 students. Each student assigned points ranging between 0 to 3 to each item. As there are a total of 52 students, maximum and minimum score of a given item may range between 156 and 0, respectively. As there are 7 worksheets included in the study, maximum score to each item will be 10902.

3. Findings

3.1. Findings obtained from interviews

Responses of students to main questions were analyzed based on their similarities in the study. Interview transcriptions were analyzed again by researchers with an interval of 8 months, and these were compared to previous results in order to enhance reliability. Comments were finalized taking identified new circumstances and data into consideration.

The prominent statements made by students in the evaluation at the end of question *"What are your opinions on the coherence of page layout, font and figures with the subject, its colorfulness, language and time in regard to usability of worksheets that were used in the research process?"* are given in Table 1.

Table 1: Student Opinions on Effectiveness of Worksheets

S13	No problem was observed on page layout, font, figure size, color and language. However, there were minor deviations in the timing of activities.
S20	I think the page layout is good but more time could have been allocated. I think too many questions were asked. Learning with questions can be good, but this is somehow tedious.
S24	I believe that page layout and font size of the test is suitable for 11th grade students. Images were used and videos were involved as necessary. Needed questions were included. In my opinion, this worksheet has been prepared very well in respect to delivering information through research and experiments rather than directly, so that 11th grade students can make researches. If text has been included to a lesser degree, students would have been less bored.
S32	It was all very nice. I want to say something about the images: While we were conducting experiments, similar images were already included on the page. This was very nice. We both saw them on the page and in real life, which made them remembered even more easily.
S35	At first, I was somehow surprised when I saw the pages. Because they had different designs than our usual books. Their colorfulness was better for us. Because colorless things are not perceived well by students.
S45	Worksheets are very intriguing. In some aspect, they attract student to the lesson more than the usual. Also, knowledge becomes permanent as students learn by doing and experiencing it. We learn more in short time. As for the page layout, it is enriched with images and visuals. It is nice.

As it is seen in Table 2, students expressed that worksheets are considerably sufficient and useful. In this regard, various studies report that having students conduct experiments with concrete materials at various stages of activities that are prepared in accordance with constructivist approach to ensure their involvement facilitates understanding subjects with abstract contents, allows them to construct the information by themselves, and enables students to experience further in-depth learning by practicing their information and experience in new situations (Acıslı, 2010; Bayrakceken et al. 2009; Demirci & Cirkinoglu, 2004; Gurbuz, 2012; Hırca, 2008).

However, students criticized that *"time was not sufficient and too many questions were included, therefore it was boring to respond them in writing"* for the activities. It is believed that these criticisms arise from the need for guidance with questions for steps based on questioning and exploring that are intrinsically included in the constructivist approach. Also, as a result of reviewing student statements and worksheets, it was concluded that the reason for students to fail in filling out the worksheets as required and to experience time-related issues arose from the fact that they had never received a lesson in constructivist approach during their overall academic life and they were reluctant to write.

In this regard; **S13** and **S24** made the following statements:

S13: *"Had students been experienced, it was obvious that no problem would have been encountered since they would have already been predisposed to it".*

S24: *"As we are a student group that is used to ready-made information, we had a really difficult time during this study period of two months. Actually, these activities were not challenging. But we encountered something to which we are not used. In fact, expected durations are appropriate. However, this took somehow longer than the expected. I mean, these activities were normally doable within the anticipated time."*

The considerations about the time allocated to activities in this respect corroborate the suggestions of Ayas (1995).

The prominent statements in the responses to the question "*What do you think about implementation of this method in physics lesson?"* are given in Table 2.

Table 2: Student Opinions on Employment of 7E Model in Physics Lesson

S13	It could be more suitable to have students comprehend certain concepts in Physics lesson with experiments.
S20	Physics contents are predominantly things that should be explored with experiments; therefore I think that it is a suitable method for physics.
S24	Physics lesson is comprised neither mathematical contents nor verbal statements in full. This method should be practiced for development of our conceptual skills. It enables us to remember them.
S32	Physics is the nightmare of several students. We can say that this is a good method to make physics

	enjoyable and pleasing.
S35	In my opinion, this was very good. Because the lessons were pleasing. It was also good since we were learning things about life. Physics can be remembered much more easily if it is instructed like this.

As it is seen in Table 2, students expressed that the employment of this method in physics lesson is suitable as the lesson process *"is oriented at exploration, is easily remembered, makes visuals and learning by doing and experiencing things prominent and is pleasing"*. In this regard, several results in the literature indicate positive contributions of employment of constructivist approach-based methods in academic success and attitude in physics lessons (Ergin, 2006; Gurbuz, Turgut & Salar, 2013; Hırca, 2008; Kanli, 2007; Keser, 2003).

The prominent expressions of students in the evaluation of the question "*In your opinion, what are the positive and negative aspects of learning physics lesson based on 7E model?"* either in direct manner or in the following questions are given in Table 3.

Table 3: Student Opinions on Positive and Negative Aspects of 7E Model

S13	It supported us as it was rather based on daily practices. We experienced and learned by ourselves. However, certain disconnections were experienced as we were not really dependent on the teacher.
S20	While learning the lesson through activities with friends in the group enabled permanent memorization of information, the fact that it lasted long affected as negatively.
S24	I am of the opinion that it was a nice activity. We learned several concepts, studied with our friends in groups, developed our communication skills and we became able to think scientifically throughout a long process of studying. When the process is extended too long, students tend to get bored. This can lead to a reluctance to the subject. I almost never studied at the initial stage of the process. I only studied when examinations were close. However, our acquirements are what matters. I am of the opinion that it was a nice activity and I acquired a lot.
S32	It was permanent since we made experiments Ferromagnetic materials, diamagnetic materials... These were really memorized well. However, continuously being at a laboratory setting and writing tend to get students bored. This should also be considered.
S35	We have to have a certain degree of knowledge at a lesson taught with 7E model. Our teacher initially explained everything to the fundamentals; however, when we compare someone who does not know anything to someone who knows to a certain extent, this model would allow someone with knowledge learn better. The negative aspect was particularly the loss of time. Students were sometimes disconnected from the lesson. These aside, it is a positive structure and a positive model in general.
S45	I think there were not too many negative aspects. Positive aspects include more permanent memorization in a shorter period of time. I acquired the knowledge as I learned by doing and experiencing it. More permanent and better results could be achieved if this method is implemented full-time.

As it is seen in Table 3, students expressed that the employment of this method is suitable as the lesson process *"includes practices from daily life, is easily remembered, makes learning by doing and experiencing things prominent and includes activities in the lesson".* In this regard, several results in the literature indicate positive contributions of employment of constructivist approach-based methods in academic success and attitude (Bozdogan & Altuncekic, 2007; Hırca, 2008; Kanli, 2007; Keser, 2003; Ozmen, 2004; Tas & Secken, 2009).

However, students expressed their opinions on the negative aspects of the model by stating that "*it is tiresome to suddenly quit the habit of previous teacher-dependent learning process and become more active, time is not enough and there are too many questions included, therefore it is boring to respond to them in writing, and being at a laboratory instead of the classroom setting they are accustomed to is tedious."* In regard to these criticisms, it is stated in the literature for the roles of teachers and students in lessons with constructivist approach that lessons should be delivered in settings with suitable tools and equipment due to the fact that the attitudes and behaviors of students are intrinsically exploratory and more active than the teacher (Acıslı, 2010; Bayrakceken et al. 2009; Hırca, 2008; Kanli, 2007). Therefore, these criticisms could probably arise from past habits of learning, and individual differences could influence this issue as well.

3.2. Findings Obtained from Observations

This section includes the findings obtained from events, phenomenon and behaviors observed at each stage of 7E model. Scores were assigned with an evaluation of frequency of actions, degree of participation and activities that should be carried out once at minimum in the behaviors according to the nature of targeted acquirements.

After researchers asked predetermined student groups to sit on tabled arranged in U-formation at the physics laboratory of the school, they informed the students on how the lesson was going to be delivered based on the distributed worksheets, and the respective responsibilities of the teacher and the students during this process. Furthermore, an emphasis was made on collective actions of students in group study to warn students about not remaining passive in performance, being attentive to potential electric shocks and usage of tools and equipment. The practice was initiated after the teacher responded the questions of students on the process.

The overall results of observation on the evaluation of behaviors expected from the teacher and the students are given in Appendix 2 for all stages of 7E model.

At the initial stage, 1.50, 1.93 and 1.73 mean scores were assigned to participation of students in discussions with their available knowledge, asking questions for comprehension of the subject and good use of time, respectively (Appendix 2). The result appears to emerge from insufficient self-confidence of students, the concern of being ashamed before the class and being inexperienced in laboratory activities.

During the process of engaging the students, teacher introduced the subject with the demonstration experiment on pages 2, 4, 5 and 7 and video display on pages 1, 3 and 6 in accordance with constructivist approach, and then asked the students to answer the questions about video or demonstration experiment on the worksheets as necessary. Students initially asked questions on what they were supposed to do on a frequent basis in this step, however they grew accustomed over time. Teacher offered guidance and gave warnings to enable in-group studies. It was observed that students responded the questions by discussing with each other. As the process advanced, the students and the teacher were observed to have accommodated themselves, being comfortable.

In the exploration stage, students played active roles in the process and attempted to carry out their activities with the tools and equipment given to them in the suitable learning environment. However, it was observed that the teacher mostly rejected the students and asked new questions in an attempt to make students more active since the students were initially trying to achieve results at once by asking questions on the result of the activity to the teacher. Furthermore, students took notes when the teacher insisted them on recording the results of the study. It drew the attention that students were not strong in collaborative action, therefore teacher warned that everyone should play a role and contribute to the process through allocation of tasks. It was also noticed that the teacher guided the students with questions to involve them in engage stage, so that exploratory activities could be meaningful to students. It was seen that the implementation of this step took longer than anticipated with a mean score of 1.50. It was observed that this delay was due to the fact that the students were both slow and had to repeat the activities for a few times since their scientific process skills were underdeveloped.

In the explain step, the mean scores evaluated for the expected behaviors of students were "*1.29 for being willing to participate in the process; 1.93 for explaining what they have understood to other students and the teacher in line with what they explored; 1.29 for questioning the explanations of other students; 1.14 for being able to interpret the meaning of concepts, figures and graphics; and 1.43 for asking questions relevant to problem solving and future activities*" (Appendix 2). We are of the opinion that the students were unaccustomed to construct the knowledge by themselves, lacked adequate self-improvement in analyzing the knowledge in theoretical and graphic aspects in mathematical terms in order to assimilate the physics-related information, had not acquired an adequate level of scientific process skills through the conventional method and fell short in expressing the information in a scientific language in the overall process. However, observations of video reveal that students achieved progress over time. In accordance with this given situation, it is reported the social improvement and communication skills, advanced thinking skills and self-confidence of students are enhanced by means of activities prepared based on constructivist approach (Bayrakçeken et al., 2009; Bozdogan & Altuncekic, 2007; Keser, 2003).

In the elaborate step, the mean scores of observed student behaviors were "*1.76 for using only the information delivered by the teacher in discussions and 3.00 for certain students being more active in the study as compared to others*". Even though there was progress in the behavior of using only the information delivered by the teacher in discussions throughout the process, the mean score fell below 2. The reason for this is the fact that students remain dependent on memorization in the previous teacher-centered teaching process (Bayrakceken et al., 2009; Gurbuz, 2012, Keser, 2003; Ozsevgec, 2007).

In the elaborate step, the behavior of asking questions such as "***What have you previously learned/known****?"*, "*What do you think about .....?"*, "*What can you do with your available knowledge that you have acquired so far*?" in order to activate the students for questioning and exploring in line with the constructivist approach was evaluated with a mean score of 1.57 while the mean score of the behavior of taking the individual differences in students into consideration was 1.36. These behaviors fell below the expected level.

In the extend step, which is an important stage of the constructivist infrastructure of 7E model, the behaviors expected from students were evaluated with the mean scores of "*1.64 for discussing the examples provided to them with group friends at first and then with the classroom and trying to find solutions; 1.00 for giving examples from the daily life in order to reinforce the topic; 1.71 for associating the existing concepts with other areas and/or other concepts/subjects; and 1.43 for applying new names, definitions, explanations and skill in new yet similar situations*" (Appendix 2). Therefore, it can be suggested that the students had difficulty in constructing the acquirements and introducing a scientific identity to them. Considering the students with weighted mean scores above 2.00 in other behaviors expected from students, it is observed that students asked inquiry questions which guided them to advanced acquirements and demonstrated the improvement of constructivist approach. Furthermore, from time to time, the teacher assigned additional homework and directly delivered information by extending beyond the role of guiding in an attempt to prevent loss of time due to the inexperience of students in the area of subjects that should have been acquired by students in daily life in response to exploratory and interpretative questions addressed by students in relation to advanced thinking skills.

In the step of exchanging ideas as a reflection of advanced cognitive improvement following the extend step, weighted mean scores of certain behaviors remained below 2.00 when the behaviors expected from students were observed (Appendix 2). These were evaluated with the weighted mean scores of "*1.50 for giving examples from daily life to reinforce the subject; 1.71 for collaborating with group friends in research; 1.86 for being willing to participate in class activities and discussions based on acquired knowledge"*. As the behavior "*giving examples from daily life to reinforce the subject*" is an action in the meta-cognitive knowledge level of evaluation aspect according to Bloom Taxonomy in scope of the subject area upon construction of scientific information, each and every student cannot be possibly expected to achieve such level of progress. However, it was observed that the behaviors at this level originated from particular interest of a few students in both classrooms. For instance, students were observed to exhibit evaluation level behaviors in sharing past experiences in scope of the subjects of electrical circuits, devices operating with electric motor and power generating dynamos". It appears that, in respect to the behavior of "*collaborating with group friends in research*", students could act independently due to an internal segregation of students who were keenly interested in the subject from those who had lower levels of interest due to their individual characteristics.

In the evaluate step, students fell below 2.00 with the weighted mean scores of "*1.79 for realizing that their performance will be evaluated during the activities and 1.50 for realizing their own deficiencies with the questions asked, and engaging in theoretical research again*" for these student behaviors (Appendix 2).

3.3. Findings Obtained from Peer Assessment

For in-group peer assessments, distribution of total scores of items of 23 behaviors within the process for 52 students in scope of 7 worksheets is given in Table 4 below.

Table 4: Distribution of Scores of Items for Peer Assessment Based on Worksheets

In-Group Peer Assessment Behaviors	Total Behavior Scores Of The Entire Sample Based On Worksheets							Total Score of Item
	1st WS	2nd WS	3rd WS	4th WS	5th WS	6th WS	7th WS	
1. Being attentive to subject	151	147	150	144	130	139	140	1001
2. Decision-making with the group	147	146	150	137	140	137	145	1002
3. Respecting the distribution of tasks in the group	151	152	150	132	134	141	141	1001

4.	Fulfilling their own task successfully in given time	147	140	137	105	123	133	146	931
5.	Giving timely and effective feedbacks to group friends	139	130	129	120	121	123	125	887
6.	Supporting learning process of group	155	147	146	139	133	137	137	994
7.	Avoiding behaviors that push other group friends to background	151	152	154	150	142	151	146	1046
8.	Volunteering for tasks and offering constructive recommendations for other activities	132	128	124	127	124	118	116	869
9.	Sharing the preliminary knowledge on the subject with friends and teacher in the classroom	106	116	125	200	104	127	110	788
10.	Completing relevant sections of worksheet meticulously	150	152	148	141	135	147	126	999
11.	Trying to recognize and use the tools, equipment and devised used in classroom activities (observation, experiment, demonstration etc.)	150	154	154	147	137	154	153	1049
12.	Listening to and trying to understand explanations of the teacher	148	148	156	245	143	148	151	1039
13.	Referring back to previous activities in explanations, using recorded observations and trying to reach logical inferences by using observation findings	137	142	128	119	119	128	122	895
14.	Recording, interpreting and analyzing observations, findings, ideas and explanations Preparing reports with charts and graphics as necessary	124	116	116	107	112	114	87	776
15.	Trying predictions and hypothesis with alternative methods and discussing these with other students	87	98	113	116	108	97	54	673
16.	Freely thinking about and trying to find solutions to questions or problems	140	143	134	130	118	137	107	909
17.	Participating in discussions by using observation results and making positive contributions with new opinions and ideas	136	138	127	138	121	129	111	900
18.	Trying to give meaning to encountered new concepts	144	139	135	120	138	139	147	962
19.	Trying to acquire new skills	130	133	141	129	133	150	149	965
20.	Applying new names, definitions, explanations and skill in new yet similar situations	133	121	116	128	128	135	116	877

21.	Listening to and questioning the explanations of other students from a critical perspective	107	93	114	125	121	140	113	813
22.	Answering the questions on the worksheet at the end of the activity	154	152	147	146	141	154	140	1034
23.	Asks questions or makes inferences on advanced stages based on acquirements (knowledge, skills, etc.)	34	36	72	66	66	67	28	369

During the practice, the 9th behavior of "*sharing the preliminary knowledge on the subject with friends and teacher in the classroom*" had a total score of 788; 14th behavior of "*recording, interpreting and analyzing observations, findings, ideas and explanations, Preparing reports with charts and graphics as necessary*" had a total score of 788; 15th behavior of "trying predictions and hypothesis with alternative methods and discussing these with other students" had a total score of 673 and 23rd behavior of "*asking questions or making inferences on advanced stages based on acquirements (knowledge, skills, etc.*" had a total score of 369 when the in-group peer assessment of student behaviors in group were considered in accordance with the nature of constructivist approach and scientific process skills.

4. Results and Suggestions

Upon examination of findings obtained from the practices in both classrooms, it was determined that the subject was highly extensive, active learning and scientific process skills of students were not adequately developed and the motivation of certain students decreased for activities. This corroborates the suggestions of Ayas (1995), Keser (2003) and Saka (2006) on the time allocated in addition to the selection of subjects and concepts to be researched in constructivist learning environment.

Discussions were carried out through the employment of question-answer method. When students were not permitted to use any resources, it was determined that students were initially surprised and they had great difficulty in attempting to define the relevant concepts in accordance with the book. However, students were encouraged to express their knowledge with their own sentences. It was realized in this process that several students lacked the confidence in their knowledge on basic concepts for magnetism, which they had learned in the previous lesson, and they were shy about it.

In the engage step, which is the first step of the worksheets, questions, demonstrations or short videos that could create a discussion about the target concept were specifically used. Thus, it was attempted to establish a direct connection on the conceptual level with the targeted acquirement with the help of questions and discussions prepared to guide students into realizing their available knowledge and deficiencies. As for the steps of engage and explore, findings obtained from observations, peer assessments, completion of worksheets and discussions indicate that students in both classrooms went through an efficient engage step and succeeded in problems and study targets in accordance with the researches to be carried out in the explore step. Upon reviewing from the aspect of exploration process, it is observed that students in both of the classrooms went through the research subjects and their tasks for these researches efficiently based on the worksheets in scope of a suitable plan in accordance with the activities carried out at the engage step. It is understood from the observations and interview findings that carrying out a different activity and the entertaining aspects arising from peer relationships led to efficient engage and explore steps for students.

It was determined that scientific language was not used sufficiently and students found writing as tedious in the activities of explain and expand steps. This is also revealed with the statements of students in the interviews. In order for conceptual change to occur, students should be provided with a learning environment in which they notice the views of themselves and the others, they discuss the coherent and incoherent aspects of these views, support their suggestions with scientific evidence, explain any possible changes in their opinions and evaluate themselves as well as others (Saka, 2006; Yildiz, 2008).

In the steps of elaborate and exchange, students were enabled to be more willing and active as the questions, videos and discussions in these steps were oriented at the daily life beyond the conceptual level, and operating principles of certain devices with a more vital and engaging nature as well as relating to the subject of magnetism. Students who had opinions were enabled to take the floor and discuss by encouraging students to make associations between the acquirements of the subjects in the activities carried out in this context.

It was determined that the students received support from group members in developing tables, drawing graphics, solving problems, calculating the results and writing the reports. However, it was determined that the expected qualities had not sufficiently developed in respect to creating data records and tables, drawing graphics or explaining what had been done in the efficient expression of causality relation with an effective interpretation of results. The interview findings reveal that the inexperience of students in laboratory played a great role in this reason.

It is revealed from the observations during the research process and findings from the student interviews that the majority of students perceived the lessons as more pleasing by virtue of the discussions in physics lesson and they learned the information permanently by virtue of the practices. Students expressed that they had done a high number of things by thinking by themselves, they established the mechanisms and researched and found the facts by themselves. Students mentioned that the information learned through their own experience and thinking was more permanent and they had the opportunity to examine the occurrences with their reasons. Furthermore, they expressed that they were more comfortable in writing their ideas and their interest in the subject was further enhances as the questions on the worksheets were linked to daily life. These findings are in parallel to the results of researches yielded by Acıslı (2010), Bayrakceken et al. (2009), Costu, Karatas and Ayas (2003), Gurbuz (2012), Hırca (2008), Hırca, Calık & Seven (2011), Kanli (2007), Kilavuz (2005), Ozsevgec (2007) and Yildiz (2008). Furthermore, various studies report that having students conduct experiments with concrete materials at various stages of activities that are prepared in accordance with constructivist approach to ensure their involvement facilitates understanding subjects with abstract contents, allows them to construct the information by themselves, and enables students to experience further in-depth learning by practicing their information and experience in new situations (Altun, Acıslı & Turgut, 2010; Bayrakçeken et al., 2009; Demirci & Çirkinoğlu, 2004; Hırça, Çalık & Seven , 2011; Yildiz, 2008).

Even though the lesson plan was followed, circumstances where the teacher acted with a conventional understanding based on past were also observed. This was particularly noticeable in the explain step, in which the teacher is more active. Teacher assuming a role that presents information and explains the points that were not understood in the classroom is not adequate for a new concept to be assimilated. It is critically important to reveal the concept-related opinions of both teachers and students in classrooms where teaching activities that support conceptual change are carried out. In parallel to this, it is emphasized in the literature that a new concept should be learned through a developmental manner rather than sudden changes expected to be observed in students (Yildiz, 2008). Teaching methods which are carried out with questions and answers and in which scientific principles are explained with formulations or examples would fall short in this sense. Situations that will lead to scientific conflict should be delivered to students in order for them to realize the opinions of themselves and other friends in the classroom. Great importance should be attached to enabling students to clearly see the conflict with their own knowledge and new information, ensuring that the evidence presented for the resolution of the conflict would actually convince the students and the having students sense the significance of conflict (Yildiz, 2008). In parallel to this, Kang, Scharmann and Gve Noh (2004) recommend that situations which would engage students should be used. A student who experiences the conflict should understand that the available concepts fall short in offering a solution and should opt for changing these concepts. Vosniadou (1994) perceives conceptual change as the continuance of the gradual change of mental model of the individual about the surrounding world. The said change is realized when concept is enriched and previous concepts are renewed. Enrichment can occur when new information is included in the existing conceptual structure whereas renewal arises from the change in the mental structure or belief. In addition to learning environment, individual characteristics of students also influence the conceptual change. It is believed that meta-cognition, belief of self-sufficiency and factors such as interest, attention and benefit value influence conceptual change (Yildiz, 2008). Misconceptions or alternative opinions of even one student on the subject addressed in the group studies are of importance as these may influence other group members as well. In order to prevent this, the teacher and all students in the classroom should record the final result inferred from discussions to the relevant section on the worksheet.

Upon reviewing Table 4, it is observed that the 9th behavior of "*sharing the preliminary knowledge on the subject with friends and teacher in the classroom*" for in-group peer assessment has a lower total score than others with 788. It is believed that this situation arises from the fact that students lack self-confidence with the thought that their preliminary knowledge is insufficient or they are sky of potential results of an inaccurate statement. 14th behavior of *"recording, interpreting and analyzing observations, findings, ideas and explanations"* has a total score of 776, which is lower than the other behavior scores. It is believed that this situation arises from the reluctance of students to writing an inadequate skills of drawing mathematical graphics and analyzing these based on the observations of researchers and statements in student interviews. 15th behavior of "*trying predictions and hypothesis with alternative methods and discussing these with other students*" had a total score of 673 and 23rd behavior of "*asking questions or making inferences on advanced stages based on acquirements (knowledge, skills, etc.*" had a total score of 369 when the in-group peer assessment of student behaviors in group were considered in accordance with the nature of constructivist approach and scientific process skills. It is believed that the reason for the low scores of these behaviors arise from the fact that these behaviors require advanced level skills on development.

There are a high number of qualitative and quantitative findings in the literature which indicate that the scientific process skills of students are improved in classroom settings where activities prepared in accordance with constructivist approach are used.

n the other hand, it is reported the social improvement, communication and manual skills,, advanced thinking skills and self-confidence of students are enhanced by means of activities prepared based on constructivist approach (Akerson et al. 2009; Bayrakceken et al., 2009; Boddy, Watson & Aubusson, 2003; Bozdogan & Altuncekic, 2007).

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Appendix 1

1. About the usability of worksheets, what are your opinions on the following:

- Page layout;
- Font;
- Size of figures;
- Color;
- Language;
- Time.

Would you like to recommend anything on any aspects that are deficient or should be corrected?

2. What are your opinions on whether the worksheets serve for their intended purpose (duration, integrity of subject)?
3. What do you think about learning the lessons through this method?
4. What do you think about application of this method in physics lesson?
5. Has this method proven useful to you in respect to associating the learned concepts with daily life?
6. Which subject did you understand better by virtue of this method? Can you explain?
7. Did you feel yourself inadequate in any circumstance during the lesson activities? Please explain if you did.
8. What do you think about exploring thinks with your group friends?
9. Can you list any activities that you remember to have done so far?
10. If you were to re-experience this process, which issues would you pay attention to and what kind of corrections and additions would you make?
11. What are your expectations from the teacher during this process?
12. What are negative and positive aspects of the practice for you?

Appendix 2

7E LEARNING STAGE		OBSERVED BEHAVIORS	Mean Score
1. STAGE: ENGAGE	STUDENTS	They are watching the introduction activity aimed to engage (demonstration or video).	3.00
		Students are focused on the introduction activity or the addressed problem.	2.64
		Students were willing to participate in the discussion with their available knowledge.	1.50
		They asked questions on the subject in order to understand it.	1.93
		They discussed the answers to the question in the introduction section with their friends.	2.36
		They completed relevant sections of worksheet.	2.93
		They used the time effectively and efficiently.	1.79
	TEACHER	Teacher started the activities with subjects and problems relevant to real life.	3.00
		Teacher attempted to reveal available knowledge of students about the new concept or subject.	2.71
		Teacher informed on how the lesson was to be carried out.	2.21
		Teacher drew attention of students to the new subject by supporting their previous knowledge and engaged them.	3.00
		Teacher asked questions to students while starting the activities.	2.50
		Teacher explained the concepts in scope of the subject.	1.71
		Teacher followed the process in accordance with the worksheet.	1.86
		Teacher encouraged students to explore by themselves rather than directly obtaining information from teacher.	2.64
2. STAGE: EXPLORE	STUDENTS	They read the worksheet and tried to prepare and apply the activity in accordance with the instructions.	2.64
		They tried to use the tools and instruments in practices.	2.71
		They allowed each other to speak within the group.	2.57
		They collaborated with each other.	2.57
		Students interactively spoke with each other and made observations.	2.93
		They took notes, analyzed data and discussed findings about the activity.	2.79
		They completed relevant sections of worksheet.	3.00
		They tried to actively participate in the learning process to the extent possible.	2.21
		Certain students were more active as compared to others during the activity.	3.00
		Students showed/tended to show their activities during the research to the teacher.	2.14
		Students helped with each other and teacher in carrying out the activities.	2.00
		They used the time effectively and efficiently.	1.50
	TEACHER	Teacher prepared suitable environment for students to conduct shared experiments.	3.00
		Teacher encouraged students to study together by offering the least assistance to the extent possible.	2.79
		Teacher asked extensive questions to students to enable them to repeat their research as necessary.	2.64
		Teacher helped with and guided the students whenever there was a problem in their studies.	3.00
		Teacher encouraged students to explore by themselves rather than directly obtaining information from teacher.	2.93
3. STAGE: EXPLAIN	STUDENTS	They were willing to participate in the process.	1.29
		They explained what they had understood to other students and the teacher.	1.93
		They used the observational data they had recorded in their explanations.	2.57
		They questioned explanations of other students.	1.29
		They made associations with the introduction as a result of the activity.	2.86
		They were able to interpret the meaning of concepts, figures and graphics.	1.14
		They asked questions about problem solving and future activities.	1.43
		Certain students were more active in the solution of encountered problems.	2.71
		They listened to and tried to understand explanations of the teacher.	3.00
		They noted down the explanations of the teacher on the worksheet.	2.71
	TEACHER	Teacher encouraged students to explain and define the concepts.	2.71
		Teacher asked students to make explanations in accordance with obtained findings.	2.86
		Teacher asked questions to help students with understanding the subject.	2.93
		Teacher made explanations by linking participation of students to exploration activities.	3.00
		Teacher asked questions on the reasons for statements made by the teacher and their own friends.	2.79
		Teacher introduced new concepts by making explanations and definitions considering past experience of students.	2.71
		Teacher used preliminary experience of students for explaining new concepts.	3.00
		Teacher demonstrated the results of the activity with figures and graphics while using the board.	3.00
		Teacher guided the students to restructure their previous knowledge on the subject.	2.64
4. STAGE: ELABORATE	STUDENTS	Students exchanged ideas with each other in order to elaborate their understanding of the subject.	2.07
		They made inferences on similar situations by using the acquirements of past activities.	2.29
		They revealed similarities of new definitions, explanations and skills.	2.14
		They linked results to concepts.	2.79
		They were attentive to have an understanding of the practices.	3.00

		They noted the observational data and explanations on relevant sections of worksheet.	2.86
		They tried to actively participate in the learning process.	2.14
		Certain students were more active as compared to others during the activity.	3.00
		They used only the information given by the teacher in discussions.	1.79
	TEACHER	Teacher asked questions such as "What have you previously learned/known?", "What do you think about .....?",	1.57
		Teacher encouraged the students to improve and extend their knowledge and skills and to use them with new	2.71
		Teacher reminded students of alternative explanations.	3.00
		Teacher considered individual differences in students.	1.36
		Teacher toured among the groups and spoke to students to attend to their problems.	3.00
5. STAGE: EXTEND	STUDENTS	They used previous knowledge to ask questions and generate solutions.	2.43
		They discussed the examples given to them with their group friends at first and then with the classroom, made	1.64
		Students gave examples relevant to daily life in order to reinforce the subject.	1.00
		They asked questions which would help with them to make associations with other concepts/subjects and fields.	2.21
		They associated the existing concepts with other fields and/or other concepts/subjects.	1.71
		They applied new names, definitions, explanations and skill in new yet similar situations.	1.43
		They used their observational findings and noted down the inferences.	2.71
		They asked questions about problem solving and future activities.	2.57
	TEACHER	Teacher gave opportunities to students for them to assimilate the concepts and improve their skills.	3.00
		Teacher asked questions such as "What have you known so far?" and "Why do you think that it is like this?" by	2.93
		Teacher tried to make the concepts more comprehensible by presenting new examples and analogies.	2.57
		Teacher asked questions and guided the students in order to reveal the similarities/associations of learned concepts	3.00
		Teacher enabled the students to rethink on the accuracy of previously learned concepts.	2.50
		Teacher encouraged students to develop more general thoughts on the situations in the activities.	2.86
		Teacher used the ideas and suggestions on the situation in the engage step in the extend step.	3.00
6. STAGE: EXCHANGE	STUDENTS	Students reinforced the subject with examples from daily life.	1.50
		They collaborated with their group friends in research	1.71
		They noticed the importance of having their contributions in the activities taken into consideration.	2.14
		They became willing to participate in class activities and discussions based on their acquirements.	1.86
		Individuals within the group tried to access the facts by discussing the information obtained from research findings	2.29
	TEACHER	Teacher enabled interaction among student groups and made students encounter ideas of each other's.	2.14
		Teacher asked questions about problem solving and future activities.	3.00
		Teacher supported accurate inferences.	2.71
		When students made inaccurate inferences, teacher asked questions to guide students into thinking and accurate	2.71
		Teacher guided students into using the results of activities.	3.00
		Teacher encouraged students to engage in dialogues with themselves and their friends in the classroom.	2.64
		Teacher used cognitive expressions such as "classify", "analyze," "predict, and "do" while developing the general	2.36
		Teacher assigned research homework.	1.79
7. STAGE: EVALUATE	STUDENTS	They realized that their performance would be evaluated during the activities.	1.79
		They tried to answer the questions by using observational findings in line with the explanations.	3.00
		Students asked questions to have a better understanding of the subject in practices.	2.43
		They expressed their opinions on the subject.	2.43
		They noticed their own deficiencies with the questions asked, and engaged in theoretical research again.	1.50
		They asked for the teacher to assist them in application of all activities.	2.36
		They completed relevant sections of worksheet and took down notes.	2.29
	TEACHER	Teacher asked open end questions such as "Why did you think in this way?, "What is your evidence to this?",	2.29
		Teacher observed whether students used new concepts and skills.	3.00
		Teacher gave different projects or homework that are associated with real life for performance evaluation.	2.21
		Teacher enabled reconstruction of knowledge by responding the questions with student participation.	2.57
		Teacher asked students to make in-group assessments.	2.71