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# Developing Instructional Activities Based On Constructivist 7E Model: Chemistry Teachers' Perspective[1]

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**ABSTRACT**

This study aimed to reveal chemistry teachers' views on the requirements and difficulties of developing instructional activities based on the 7E Model, as well as their suggestions to overcome them and its appropriateness for chemistry teaching. Through use of a training model with coaching, a seminar was conducted on the revised chemistry program, constructivist learning and its applications. For six months, 30 teachers prepared 78 instructional activities with coaching by the researchers. Survey findings showed they had difficulties, especially in transferring knowledge and making relations, writing scripts for drawing attention, engaging students in learning and exploring the material, and accessing related resources in Turkish. Although they indicated that it was difficult and time-consuming for them to develop activities based on the 7E Model, they implied that it provides positive contributions to meaningful learning and learning by inquiry, which are essential in science education.

**Keywords:** Constructivism; Chemistry Teaching; Chemistry Teachers' Opinions; 7E Model.

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## INTRODUCTION

Understanding the effects of constructivist and inquiry approaches on science education and studying students' abstract reasoning abilities have become very important issues. To learn by the inquiry approach is to study continuously; hence, through intellectual development, this method has come to be called a "learning cycle." Using this approach, students must think critically in order to find knowledge by themselves. To start with, the learning cycle was divided into 5 phases (Bybee, 1997). Eisenkraft (2003) added 2 more phases: the elicitation phase and the extension phase. There are numerous teaching methods for the 7 phases as follows, (1) The elicitation phase requires teachers to ask students questions so as to motivate them to express their own knowledge. After this, teachers will plan how to teach according to the students' knowledge. (2) The engagement phase is the motivation stage. Teachers must motivate students to be curious to learn, for example by telling interesting stories before a lesson. (3) The exploration phase entails identifying ways of exploring and checking, setting hypotheses, identifying possible choices, practicing to collect data to form a basis for the next phase. (4) The explanation phase takes place after students have sufficient information to be analyzed, summarized and presented in various formats. (5) The expansion or elaboration phase allows students to combine the new knowledge they have acquired with their prior knowledge, or to use the model or the conclusion to explain another case. (6) The evaluation phase comprises teachers' assessment, where various techniques may be used to determine students' understanding of the material. (7) In the extension phase, teachers are reminded of the need for students to practice the transfer of learning. Teachers need to make sure that the acquired knowledge is applied in a new context in students' daily lives. Teachers should also motivate students to use their knowledge to gain new information.

Third International Mathematics and Science Study (TIMMS) (2007) and Programme for International Student Assessment (PISA) (2009) reports indicated that, in Turkey, new approaches to chemistry learning and teaching were required because of the lack of connection between theory and practice in chemistry curricula, leading students to answer "What?" questions instead of "How?" questions. Mbajiorgu and Reid (2006) reported the criteria for chemistry curricula to be addressed in their report, "Factors Influencing Curriculum Development in Chemistry," as follows: (1) Meet the needs of all learners; (2) Relate lessons to real life; (3) Reveal chemistry's role in society; (4) Have a low content base; (5) Stay within the information processing capacity of the students; (6) Take language and communication skills into account: (7) Aim at conceptual understanding; (8) Offer genuine problem solving experiences; (9) Use lab work appropriately; (10) Involve appropriate assessment. It is indicated by TTKB (2007) that based on constructivism, the current chemistry curriculum, which went into effect in the 2008-2009 academic year, encompasses these criteria.

When we reviewed the literature concerning constructivism, labs, and chemistry instruction, we came across numerous findings, such as Shiland's (1999) study that sets forth a checklist for arranging lab settings. This checklist included the following elements: (1) Students should define variables themselves; (2) They should design procedures in the scientific process on their own; (3) They should make tables; (4) They should apply standard procedures in their work; (5) They should detect error resources and eliminate them; (6) Lab work should remind students about their early misconceptions; (7) Students should estimate and elaborate; (8) Lab work should lead students to other problems related to the same topic; (9) Students should be allowed to estimate and elaborate before performing the experiment and to discuss the results after the experiment; (10) Students should have an opportunity to work after the experiment. Başdaş, Kirişcioğlu, & Oluk (2006) emphasized the importance of hands-on methods in science instruction and reported its benefits for students, such as providing exploration opportunities with creative, flexible and critical thinking and making inferences. In another study, Fox (2001) handled constructivist theory from a learning approach point of view and claimed that this is a promising approach for education. If teachers aim to realize their students' natural learning capacities, they need to refrain from giving them information directly and should not neglect the fact that previous knowledge affects the formation of new knowledge. Thus, he emphasized that learning was not a problem of teachers and teaching. In her study, Bağcı (2001) focused on how we should apply constructivism in science education. She claimed that most of the theories and techniques were not new; some of them were applied in learner-centered approaches.

Previous studies related to the development of science courses based on constructivism, as well as several positive effects of such courses on students' science achievement and attitudes towards science were reviewed (Boddy, Watson, & Aubusson, 2003; Demircioğlu, Özmen, & Demircioğlu, 2004; Ebrahim, 2004; Feyzioğlu, 2006; Gönen, Kocakaya & İnan, 2006; Kanlı, 2007; Sribunnam & Tayraukham, 2009; Wilder & Shuttleworth, 2004). Among these studies, Demircioğlu et al. (2004) developed learning activities based on the 5E Model concerning "The factors affecting solubility balance" and applied them in a science course. At the end of their study, the researchers interviewed the science teacher; he reported that he was convinced of the effectiveness of such learning activities. On the other hand, he implied that such activities were not appropriate for all science topics and that the scope of secondary school science is very broad. In addition, he reported that students were reluctant to engage in such learning activities, and this had a negative effect on developing such learning activities for them. Evans (2004) also applied the 5E Model in lab activities and concluded that the students were actively involved in the learning activities, took responsibility for learning and enjoyed their work. However, he implied that in order to apply the 5E Model, teachers required much more time for instructional activity development. Çepni, Akdeniz, and Keser (2001) developed instructional materials for physics, chemistry and biology topics based on the 7E Model. In their study, the materials they developed were assessed and corrected by science educators, and the researchers interviewed the science educators about the possible effects of these materials in real life. The results of these interviews revealed that i) students are able to learn more thoroughly with this approach; ii) too much time is required for using such materials; iii) schools may lack the necessary physical conditions. Among such studies, however, there is a lack of research regarding chemistry teachers' views, and especially their difficulties in applying constructivist learning principles in planning and developing science learning activities. Therefore, it is crucial to reveal the views of chemistry teachers who had experience in learning the 7E Model through training with coaching and subsequently developed instructional activities based on this model.

The chemistry curriculum in Turkey has been revised based on a constructivist approach, and the new program was put into effect for the 2008-2009 academic year. Consequently, it is important to provide professional development opportunities for chemistry teachers who must understand the constructivist learning paradigm and develop instructional activities accordingly. One of the professional development models, the training model, was selected for the participant chemistry teachers. Guskey (2000) implied that the training model is the most efficient and cost-effective model for sharing ideas and information with large groups of educators. Hence, effective training generally includes demonstrations or modeling of skills, simulated practice, and feedback about performance, as Joyce and Showers mentioned (as cited by Guskey, 2000, p.23). Therefore, a training model with coaching was applied for the chemistry teachers in the workgroup. While developing instructional activities, the participant chemistry teachers encountered several obstacles, most of which may have been unfamiliar to them. Therefore, these obstacles, along with the teachers' opinions about applying the 7E Model were gathered using a survey. These reflections were considered to be useful as feedback for the project team, as well as for researchers interested in developing chemistry learning activities based on the 7E Model.

In order to understand teachers' perspectives in developing instructional chemistry activities, we administered a questionnaire to answer the following research questions:

1. How difficult is it to develop chemistry learning activities based on the 7E Model?
2. What are the obstacles to developing chemistry learning activities based on the 7E Model, and how can they be overcome?
3. What are the requirements for developing chemistry learning activities based on the 7E Model?
4. How feasible or appropriate is the 7E Model to apply?

## METHODOLOGY

### a) Participants and Training Procedure

In this survey study, in accordance with the purposive sampling method, the sample included the chemistry teachers (n=30) in the workgroup. They have been working at private or public secondary schools in İzmir for 6 to 26 years. They were selected from a group of volunteering chemistry teacher applicants to work with the prospective computer teachers from the Faculty of Education at Ege University. Fourteen of them had M.Sc. degrees, and four of them had PhD degrees in chemistry. Seven of them are working at vocational high schools, while seven of them are at intensive foreign language high schools (Anatolian high school); three of them are working at a science high school, three of them are from public schools, and the others are employed at various other schools.

In the context of the study, the teachers were asked to develop learning activities based on the 7E Model. To do so, they attended 16-hour seminars on the constructivist 7E Learning Model; learning material design and development for chemistry instruction; new approaches in information technology-assisted chemistry instruction; scientific process skills and lab types. Moreover, the teachers were presented learning activity sheets and an example learning activity developed by the researchers based on the 7E Learning Cycle Model proposed by Eisenkraft (2003). The notes from these seminars and activity sheets were also shared with the participants, both in written and electronic formats. For the next six months, each teacher was asked to develop four or five activities under the guidance of the researchers and received feedback continuously via e-mail and phone. They also had a chance to come together with the researchers once a week and asked questions about their activities face-to-face.

### b) Procedure

The data was collected using a 32-item questionnaire. To ensure content validity, four experts (a measurement-assessment expert in education, a curriculum and instruction expert and two chemistry education experts, who all had a PhD degree in their respective disciplines) reviewed the draft version. They all provided recommendations for modifications, such as rephrasing items and deleting repetitive and improper items. The questionnaire included 32 semi-structured items about time allocation for developing activities at each stage of the constructivist 7E Model and scientific process skills (14 items) and ratings for their levels of difficulty (14 items), possible reasons for the obstacles/problems encountered (4 items), the requirements for developing chemistry learning activities based on the 7E Model, and personal views about the 7E Model. The questionnaire was administered to the teachers in the workgroup. However, eight questionnaires were incomplete and were excluded from the data analysis.

### c) Data Analysis

The data was analyzed using descriptive analysis methods, and frequency of the responses was provided; since the number of the respondents was relatively small, the percentage of the responses was not provided.

## FINDINGS

The findings were organized according to the research problems as follows:

### *a) Results about difficulty levels of developing chemistry learning activities based on 7E Model stages*

**Table 1.** *The Teachers' Responses for the Level of Difficulties They Experienced in Developing Activities Based on the 7E Model (n=22)*

| The stages in 7E Model | Frequencies for the level of difficulty in development | | | | |
|---|---|---|---|---|---|
| | 1 Very easy | 2 Easy | 3 Moderate | 4 Hard | 5 Very hard |
| **Preparation for 1E – Elicit prior understandings** | | | | | |
| Informing about the objectives | 2 | 9 | 6 | 4 | 1 |
| Eliciting prior understandings and motivate | 3 | 9 | 3 | 5 | 2 |
| Attracting student's interest | 2 | 6 | 11 | 2 | 1 |
| Focusing on thinking | 1 | 7 | 9 | 5 | 0 |
| **2E – Engage** | | | | | |
| Assigning variables | 2 | 8 | 8 | 2 | 2 |
| Adjusting hypothesis(es) | 5 | 7 | 6 | 3 | 1 |
| Experiment | 4 | 9 | 4 | 4 | 1 |
| Making estimations | 4 | 12 | 4 | 2 | 0 |
| Making tables | 1 | 11 | 7 | 2 | 1 |
| **3E - Explore** | | | | | |
| Drawing graphics | 1 | 13 | 4 | 4 | 0 |
| Making conclusions | 3 | 10 | 7 | 2 | 0 |
| **4E – Explain** | | | | | |
| Applying to new circumstances | 1 | 6 | 7 | 6 | 2 |
| **5E – Elaborate** | | | | | |
| Making connections and relations | 2 | 3 | 9 | 5 | 3 |
| **6E – Evaluate** | | | | | |
| Evaluation | 4 | 8 | 8 | 2 | 0 |
| **7E – Extend** | *not reported* | | | | |
| Sharing with others | | | | | |

The chemistry teachers reported that the difficulties they experienced in developing activities based on the 7E Learning Cycle Model included relating the material to real life (n=3) and applying it to new circumstances (n=6), except in the 1E and 2E stages. Table 2 presents the amount of average time the teachers reported that they spent for developing activities based on 7E Model.

**Table 2**. *Average Time for Developing Activities Based on the 7E Model (n=21)*

| The stages in 7E Model | Frequencies for the amount of average | | | | |
|---|---|---|---|---|---|
| | 1- 30 min. | 30 min.- | 1 - 2 h. | 2-3 h. | Above 3 h. |
| **Preparation for 1E – Elicit prior understandings** | | | | | |
| Informing about the objectives | 7 | 7 | 4 | 1 | 2 |
| Eliciting prior understandings and motivating | 6 | 11 | 2 | 1 | 1 |
| Attracting student's interest | 4 | 9 | 4 | 2 | 2 |
| Focusing on thinking | 6 | 5 | 4 | 4 | 2 |
| **2E – Engage** | | | | | |
| Assigning variables | 10 | 5 | 6 | 0 | 0 |
| Adjusting hypothesis(es) | 9 | 8 | 4 | 0 | 0 |
| Experiment | 3 | 8 | 4 | 3 | 3 |
| Making estimations | 4 | 13 | 3 | 1 | 0 |
| Making tables | 6 | 9 | 5 | 1 | 0 |
| **3E - Explore** | | | | | |
| Drawing graphics | 5 | 8 | 8 | 0 | 0 |
| Making conclusions | 9 | 9 | 2 | 1 | 0 |
| **4E – Explain** | | | | | |
| Applying to new circumstances | 0 | 8 | 10 | 3 | 0 |
| **5E – Elaborate** | | | | | |
| Making connections and relations | 0 | 8 | 6 | 7 | 0 |
| **6E – Evaluate** | | | | | |
| Evaluation | 3 | 7 | 7 | 3 | 1 |
| **7E – Extend** | | | | | |
| Sharing with others | 0 | 0 | 0 | 0 | 0 |

As is presented in Table 2, the teachers mostly implied that they spent time on preparation for the experiment and evaluation. When we reviewed these stages, they spent relatively more time for the first stage, 1E - Eliciting prior understandings, which included relating the concepts to real life, focusing on thinking about the concept and making connections and relations.

### *b) The obstacles for developing chemistry learning activities based on the 7E Model and suggestions to overcome them*

The chemistry teachers have stressed that their major obstacles or problems in developing activities based on the 7E Model were *lack of time* (n=6), *writing scenarios* (n=5) and *relating the content to daily life* (n=5). One of the teachers noted that since he did not understand constructivist learning clearly, he had problems in instructional activity development; one of them thought that he was not good enough to get learners to discover the concepts; one of them complained about the abstractness and difficulty of the experiment for classroom practice, and the other two complained about scenario development for relating the materials to real life. It was also mentioned that in secondary schools, organic chemistry has been taught without the use of lab experiments; hence, the teachers had problems developing experiment activities due to their limited experience. Another major problem for developing activities based on the 7E Model was the teachers' time allocation issues related to their intensive course workload.

The teachers were also asked to provide solutions or suggestions to overcome these obstacles they had encountered. They reported that, in particular, working with their colleagues (n=5), exploring foreign web sources about chemistry (n=3), exchanging ideas with the project team (n=3) helped them to overcome the problems. One of the teachers implied that their course workload should be decreased, as they explored and studied the content in more depth than before. They also complained about the lack of information on the web in Turkish and they had to search for resources in English. In order to fulfill the need for equipment, they stated that they collaborated with local enterprises related to chemistry and personally performed experiments before developing activities based on the 7E Model.

### c) The requirements for developing chemistry learning activities based on the 7E Model

Another open-ended question in the form aimed to reveal what the teachers required while developing the activities. According to their responses, they needed chemistry books, in addition to laboratory guidebooks (n=10); time (n=3); the Internet (n=2); and resources about problem based learning (n=1). In order to relate the content to real life, the teachers looked for sources including such relations (n=1), as well as activity and scenario examples related to the content (n=2). They also needed the ability to exchange ideas with their colleagues (n=2); chemistry labs (n=2); and lab equipment in addition to chemicals (n=1). One of the teachers stated that he was content and had no extra requirements for developing activities.

The teachers were also asked to share their opinions about what else is necessary when applying these activities in classroom settings. The teachers in the workgroup mentioned that in order to succeed in applying the 7E Model, instructors should be well-informed about this model (n=3); curriculum revision for adoption of this model (n=2), time (n=1) and visual enrichment of the activities (n=1) are required. One of the teachers also stated teachers from other disciplines should also be well-informed about constructivist learning.

### d) Compatibility or appropriateness of the 7E Model for use in classroom activities

The teachers' responses to the question "Do you think the7E Model is compatible/ appropriate for use in classroom activities? And what are your suggestions for applying it effectively?" varied, as presented in Table 3. The majority of the participants (14/22) reported positive views on the appropriateness of the 7E Model in chemistry instruction.

**Table 3.** *The Responses to the Question "Do You Think the 7E Model is Compatible/ Appropriate for Use in Classroom Activities?" (n=22)*

| | | Responses | f |
|---|---|---|---|
| Categories | **Yes (n=14)** | Student-centeredness. | 2 |
| | | Appropriate if the classroom is well-equipped. | 2 |
| | | Appropriate, since it introduces new approaches in chemistry teaching. | 1 |
| | | It intends to motivate the learner. | 1 |
| | **No (n=7)** | Inappropriate for crowded classes with lack of attention and prior knowledge. | 1 |
| | | Partially compatible, since the classes are very crowded. | 1 |
| | | Not appropriate for all topics, PC is also a requirement. | 1 |
| | | The content of our curriculum is very broad for this model. | 1 |
| | | The number of teachers who can apply this model is limited, and not every class has sufficient cognitive skills for this model. | 1 |
| | **Both yes and no (n=1)** | It is not possible to teach everything just through experiments. | 1 |

## DISCUSSION

Based on the findings, the teachers reported that they mainly had difficulties in relating the material to real life, including informing the learners of the objectives, focusing on thinking, applying the material to new circumstances and relating it to other material. However, students' abilities to associate what they have learned at school to real-life situations are the indicators used by the education system to discriminate students' real understanding from rote memorization of the content. The information gained during instruction can be permanent only if it is associated with real life and can be easily adapted to new circumstances (Özmen, 2003). As implied by Aydın (2008), one of the aims of education is to organize learning settings for applying information to real life. Therefore, teachers must take their time to make school and real-life connections, even if it is not an easy task.

As possible reasons for the difficulties they experiences, the teachers implied that the student selection system for higher education is one of the main arguments, since it is not cohesive with the assessment dimension of constructivist learning theory. They also stated that they were confused about how to apply the new chemistry curriculum (as of 2008) based on constructivist theory, although they had received in-service training on its application. It is considered that, generally, the reasons for their difficulties may stem from their resistance to the new chemistry curriculum because of their familiarity with traditional teaching and learning methods and their exclusion of lab applications in chemistry courses, although chemistry is an experimental science (Ekici, Ekici, & Taşkın, 2002). Moreover, it is considered that during their teacher education, the teachers received intensive training in chemistry; however, some skills about how to relate this information to real life/daily life and new circumstances seemed to be underdeveloped within the courses. It can be inferred that this may be a reason for the teachers having difficulties in both activity development and relating the content to real life, as Özmen (2003) also implied. In another study (Başkan, Alev, & Atasoy, 2007) it is noted that the teachers' difficulties in relating the content to real life in science lessons is because of their lack of knowledge of science issues.

The teachers in the workgroup also indicated that they had encountered difficulties during experimental set-up of abstract, theoretical issues. Among the reasons for their problems, they cited that they did not have enough resources and that they lacked experience. Their statements about the difficulty of applying the 7E Model even in experimental issues led us to consider their lack of information related to new approaches in instruction and other instructional methods, as Başkan et al. (2007) mentioned. This interpretation is supported by their statements about their difficulties in guiding students to discover the concepts, rather than giving the information directly.

Recently, in Turkey as well as in other developing countries, extensive curriculum development studies in chemistry education have been conducted. The researchers who participated in those studies suggest that courses should be student-centered and include inquiry and interpretation activities (Akben & Köseoğlu, 2010; Akçakın, 2010; Bağcaz, 2009; Sevinç, 2008; Taşkoyan, 2008). It is also claimed that with the help of proper instructional materials, in addition to appropriate instructional methods, students will be able to construct knowledge in their minds more easily. Instructional materials developed in consistency with student-centered lessons can contribute to students' problem solving skills, data collection and analysis, making interpretations and inferences, and learning science concepts through inquiry (Feyzioğlu, 2006; Özen & Karaman, 2001; Tatar, 2006). Although the teachers indicated that it is difficult and time-consuming to develop activities based on the 7E Model, they also reported positive views about the effects of these activities on students' meaningful learning by relating experiments to real life and guiding students in learning by inquiry. This view was supported by previous studies (Baker & Piburn, 1997; Çepni et al., 2000; Demircioğlu et al., 2004).

The teachers in the workgroup were concerned that chemistry teachers and students might resist applying instructional activities based on the 7E Model in the classroom. Among their reasons, overly crowded classrooms (Johnstone, 1989); students' familiarity with traditional methods; intensive content and limited time in the program; lack of labs and lack of security in labs (Yılmaz, 2005); and inability to integrate assessment methods based on constructivist models were cited. Considering all these difficulties, teachers who are asked to apply instructional methods based on constructivist models should be well-trained with professional development (in-service training) activities which are not only theoretical, but also applied, including example activities. Their lack of resource materials should be resolved, and they need to be encouraged to apply such models in their lessons. When we consider the teachers' difficulties in the stage of guiding students in discovery, professional development activities for applying active learning methods and techniques is a requirement. Teachers participating in such training can learn to develop instructional activities by themselves and apply them in their lessons. Therefore, it is believed that they can become familiar with developing and applying instructional activities based on constructivist models and will be able to internalize active learning processes better.

## CONCLUSION

This study, including the perspectives of chemistry teachers who had training and coaching facilities for developing activities based on the 7E Model, is believed to provide insight for researchers interested in developing chemistry learning activities based on the 7E Model. In modern science programs, the teachers are responsible for developing and/or applying appropriate teaching strategies (Aydın, 2008). Although the number of the participant teachers in this study is limited, the study seems to help with closing the gap between chemistry teachers' experiences and their views about developing activities based on the constructivist 7E Model as a part of their professional development.

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