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Application of Task Analysis Method to Physics Laboratory Experiments

(Görev Analizi Yönteminin Fizik Laboratuarı Deneylerine Uygulanması)

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Abstract: The importance of lab studies is especially evident for science courses such as physics where abstract concepts are frequently used. The fact that the students comprehend the experiments better, and that they are better organized while doing the experiment will ensure that they will be more interested in the laboratory and thus in the topic. For this reason, it is likewise important to develop new techniques to use in lab activities. Guidelines for laboratories are of great help for students in comprehending and performing the experiment. It is an important necessity that the guidelines should frequently be renewed and that adjustments should be made to meet the changing needs of students. In this study, task analysis method is covered to be used in experiment guidelines. In this method, the steps to be followed by the student are provided on a diagram, and through cycles, missing or forgotten steps, if there are any, are determined. Thus, the students can see the whole of the experiment with all of its steps with the help of the diagram, and by relating it on the diagram; they will be able to understand What they do, and Why they do it.

Keywords: physics experiments, task analysis method, laboratory studies, physics education.

Öz: Laboratuar çalışmalarının fizik dersi gibi soyut kavramların sıkça yer aldığı fen eğitimi derslerinde yeri ve önemi büyüktür. Öğrencilerin deneyleri daha iyi anlaması ve deneyi yaparken daha planlı çalışması onları laboratuara karşı dolayısı ile konuya karşı daha ilgili ve meraklı kılacaktır. Bu nedenle laboratuar etkinliklerinde kullanılmak üzere yeni tekniklerin geliştirilmesi önemlidir. Laboratuar kılavuzları deneylerin anlaşılmasında ve yapılmasında öğrencilere büyük yardım sağlar. Deneysel etkinlikler için öğrencilerin kullandığı kılavuzların sık sık yenilenmesi, öğrencilerin değişen ihtiyaçlarına göre düzenlemeler yapılması önemli bir gerekliliktir. Bu çalışmada fizik laboratuarı deney kılavuzlarında kullanılmak üzere görev analizi yöntemi ele alınmıştır. Bu yöntemde görevi gerçekleştirecek olan kişinin takip edeceği aşamalar bir diyagram üzerinde verilir ve döngülerle eğer varsa eksiklikler ya da unutulan aşamalar tespit edilir. Öğrenciler deney süresince diyagram yardımıyla deneyin tamamını tüm aşmalarıyla birlikte görür halde olacaklardır ve Neyi? Neden? yaptıklarını diyagram üzerinde bağlantı kurarak daha iyi anlayacaklardır.

Anahtar Kelimeler: fizik deneyleri, görev analizi metodu, laboratuar çalışmaları, fizik eğitimi.

Introduction

In order for an effective learning to take place, permanency of the acquired knowledge is highly important. In order for the new knowledge to settle in the permanent memory, to have this knowledge in the visualized form is helpful (Algan, 1999). The lab is the ideal environment to support the instructor in this matter. The lab study is a very important technique by which the course can be made interesting and enjoyable; it is also a very important technique that can be used by the teachers to increase the efficiency of the topics dealt with in the classroom. With the help of this technique, the students can be more constructive and creative; moreover, they can develop new ideas on the meanings of the concepts and formulas that they use in theoretical classes. This provides great help to effective learning, and it has, without a doubt, a positive effect on the student's success (Nuhoğlu and Yalçın, 2004; Güven and Gürdal, 2002).For this reason, it is highly important that both the students and the instructors develop a positive attitude towards labs (Nuhoğlu and Yalçın,2004; Özdemir and Azar, 2004; Nahuoğlu,Kocabaş and Bozdoğan, 2004). The lab environment in school is less formal than the on in class environment, and it enables a more cooperative interaction between students, it provides more creative opportunities, and it also creates a more positive learning environment (Hofstein and Lunetta, 2004).

As is known, physics is usually a subject which students find difficult to understand, and thus they easily develop negative attitudes towards it. In physics classes, it is really difficult to provide motivation and to eliminate prejudices for a teacher/instructor who tries to realize effective learning his class. In this respect, in order for a permanent and effective learning, physics classes should be supported with lab studies (Güven and Gürdal, 2002). Carrying the class to another environment from time to time, namely, to a lab, and assisting the class with experiments will make the course more enjoyable and it will enable the students reify the concepts and formulas in their minds so that they can see WHAT they use and WHY they use it. The outcome to be expected here is the increase in students' motivation with the increase of their self-confidence. For this reason, lab studies are important for physics classes. Supporting lab studies with other techniques plays an important role in preparing a more effective lab environment.

The aim of this study is to provide assistance to the students and the teachers by using task analysis technique.

Task Analysis Technique

Task analysis is a technique which plans a complicated task that is to be completed and which gives this in the form of a sequential operations diagram. The task analysis method is frequently used in various different fields such as the military, between the employer and the employee, in many types of business, to increase performance (Riley JM and Endsley MR,2002; Annett J and Stanton N,2000). In the task analysis method, we give task information to the person who will apply the method. If the problem to be solved is complex and comprehensive, then, one should be careful when forming the diagram because there may be sub-tasks following the main task. Whether these tasks are realized or not is controlled with feedbacks. Thus, the person performing the task finds the opportunity to control both whether there are incomplete parts and whether there is a mistake when realizing the task.

Task Analysis Forming Method

The task analysis scheme should follow the following steps:

1) A definition of the task which is going to be analyzed is made
2) The task may require sub-tasks. If more than one main task is determined for the target task, sub-tasks may be formed for each of the main tasks.
3) Each sub-task is given in separate boxes under the related main task
4) Depending on the nature of the problem, how much detail is needed is decided
5) A reader-friendly diagram is formed.

Preparing a Lab Guideline with the Help of Task Analysis Technique

A good understanding of how the experiments will be done and what kind of tools are to be used in what way helps the application be easier and more efficient. Because of this, how the guideline is prepared is important. A study on this issue reveals that the information given before the experiment is insufficient and that the laboratory handbook is not helpful enough (Karaca, Uluçınar and Cansaran, 2004). In the same study, it is pointed that laboratory handbook should be more understandable and more comprehensive. Another study displays that the laboratory handbook should be renewed (Akdeniz, AR, and Karamustafaoğlu, O, 2003). Due to this reason, it is necessary to make use of different techniques while preparing the guidelines so that the experiments are comprehensible and effective. The student may not remember all stages of the experiment especially in long and multistage experiments, or he may confuse the sequencing. He may forget some of the data he is supposed to take. Because it is impossible to turn back to the construction stage in some experiments, continuing with the experiment in the face of forgotten data becomes meaningless since a missing data in the calculation stage would impede us from reaching the solution. For this reason, giving a task analysis scheme after the exposition of the experiment and how it is made reminds the student the stage/s of the experiment that escaped notice, and it gives the student an organized study plan. Comparing the guideline and the task analysis scheme prepared by the student, one can let the student begin the experiment if there are no incomplete parts. Thus, the student may have a more clear understanding of the task.

Below is a general task analysis diagram to be used in lab guidelines. The diagram;

1) Provides foreknowledge about the experiment: The student comes to the experiment having done the necessary literature research. He learns the concepts and formulas about the topic.
2) How the experiment is made is learned
3) In this stage, the tools necessary for the experiment are determined.

   3.1) The chosen tools are made ready to be used.
4) The student sets up the experiment mechanism.
5) The student makes the experiment.

   5.1) In this stage, if the experiment is long and multistage, each stage is shown on the diagram separately. Related data for each stage is taken. Data-check is done, and if there is any omission, the student returns to stage 5. If there is no omission, then, he continues with 5.2. However, for some experiments, it is virtually impossible to return to the previous stage. In such experiments, when there is a lack of data, making the experiment from scratch is required.

   5.2) Calculations are made by using the data.

   5.3) Results are obtained.

6) The experiment is evaluated with all of its stages.

6.1) The results are compared to literature. If the results are compatible with the literature, the student moves to 6.2). If not, he returns to the 2nd step. Or, if there is a suspicious stage, he returns to that stage (if returning is possible).

6.2) Results are interpreted.

The task analysis diagram to be prepared shows differences for each experiment because each experiment gives the student a different task and each different task is realized through different stages.

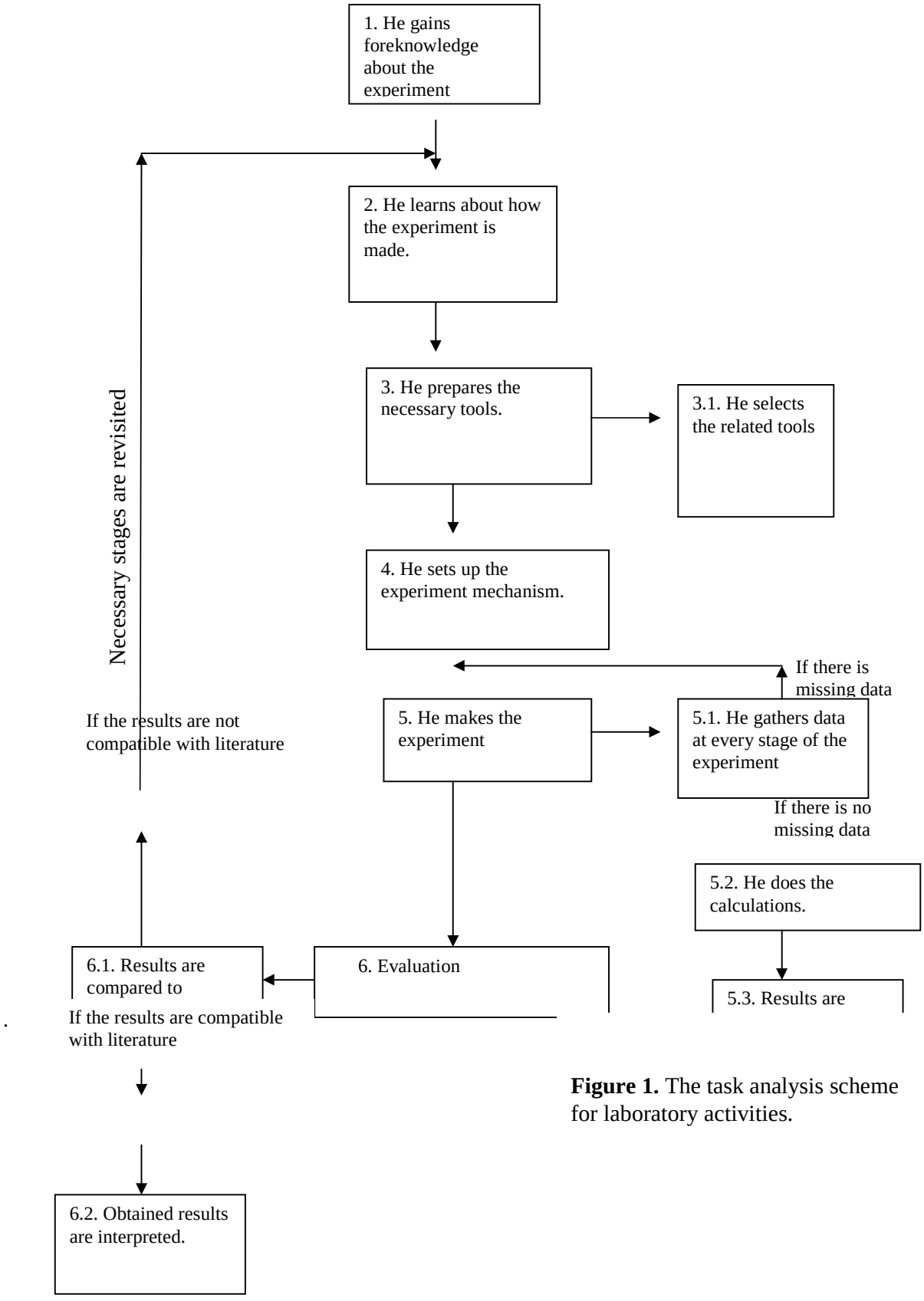

Figure 1. The task analysis scheme for laboratory activities.

Conclusion and Suggestions

The importance of lab studies in science teaching has been addressed in recent studies. Lab studies in science teaching have a very central and distinct role, and science teachers have contended that lab activities have several benefits for students (Hofstein and Lunetta, 2004). Lab studies are highly important for classes such as physics which consist of abstract concepts, too. Visualization of the topic and enabling the students to try and reach the results themselves increase their interest in and attitude toward the course. In this respect, it is a necessity both for the instructors and the students that lab studies should be adorned with different techniques. The guidelines used by the students for experimental activities should frequently be renewed; adjustments should be made to meet the changing needs of students. With this theoretical study, a more effective use of lab guidelines both in high schools and in undergraduate levels will be possible. The students will be able to study in a more organized way in experiments that are complex and that require much data-gathering. In the control stages, they will be able to revise what they have done during the experiment and what more they should do so that, if they have any mistakes, they will have the opportunity to correct them without much delay. During the experiment, they will be able to see the whole of the experiment with all its stages on the diagram. The students will be able to understand What they do and Why they do it on the diagram. Because everything that is done and every data that is obtained during the experiment are organized in the form of a diagram, this technique will help the student in preparing a report after the experiment. Task Analysis Technique can also be applied to chemistry and biology labs, and lab guidelines for these can also be prepared.

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After graduating from the Department of Education of Physics at Hacettepe University she had started to work as a research assistant at the same department in 1996. She has completed her Masters and PhD programs at the Physics Department at METU (Middle East Technical University). My specialty is in forming analytic and numeric solutions for wave equation in fiber-optic cables in cylindrical shape. I am still employed at Hacettepe University as a lecturer at the Faculty of Education. I am doing research in Problem stating and problem solving in Educational Sciences and material development for physics laboratories.