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Conference Paper *in* AIP Conference Proceedings · February 2018

DOI: 10.1063/1.5025996

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Citation: AIP Conference Proceedings **1935**, 110002 (2018); doi: 10.1063/1.5025996
View online: https://doi.org/10.1063/1.5025996
View Table of Contents: http://aip.scitation.org/toc/apc/1935/1
Published by the American Institute of Physics

Investigating the High School Students' Cognitive Structures about the Work Concept

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Abstract. The purpose of this study is to determine the high school students' cognitive structures related to the concepts of work. The participants of the study were composed of the students enrolled in 11. and 12. class of an Anatolian high school in Turkey. The data were collected via word association test related to the key concept to determine the students' cognitive structures. The collected data were analyzed according to the content analysis method. In the data analysis process, we determined firstly the number of words, the number of answers and the semantic relations between the words written by students. The words having semantic connections were grouped under the same category. Thus, at the end of the study, high school students' cognitive structures and some alternative conceptions were determined related to concepts of work.
Keywords: Alternative conception, cognitive structure, word association test, work concept

INTRODUCTION

A close examination makes it clear that student-centered approach is adopted curricula developed in recent years and that process-based rather than outcome-based approach is influential in those curricula [1,2]. Those curricula prefer mentality in which students themselves have access to knowledge, they make sense of the knowledge and they can associate the knowledge with other concepts instead of mentality in which students are directly presented knowledge [3]. Along with such an approach, concept teaching became important for the teaching of science/physics. Concepts are abstract by their nature and individuals make sense of them through a series of mental processes. Setting out from this point, students' cognitive structures for concepts became even more important in concept teaching from the perspective of educators [4]. A concept of its definition may not mean anything on its own in the teaching of concepts. On the contrary, it is necessary to form meaningful ties between concepts in students' mind in order for meaningful learning to occur [5]. Mental schemata of this type emerging should be determined. At this point, the issue of how to analyze those ties by educators gains importance. This cannot be determined in traditional measurement and evaluation methods. Alternative methods of measurement and evaluation, on the other hand, are not only outcome-based but they also include the process of learning the knowledge. In this way, both process and outcome are included in assessment [6]. In this context, one of the effective techniques in revealing cognitive structure is word association test (WAT). Of alternative measurement and evaluation methods and techniques, it is the one which dates back to the most remote past and which has the widest areas of use [7]. WAT, which was found to have been used in several studies in the literature [8, 9,10], is used in this study so as to analyze high school students' cognitive structure about the concept of work.

METHODOLOGY

This study employs qualitative research method. In order to analyze the students' cognitive structure about the work concept WAT was prepared by the researchers and used as a data collection tool in this study. 136 students in total were included in the study. The concept of "work" was chosen as the key word in accordance with the purpose

Turkish Physical Society 33rd International Physics Congress (TPS33)
AIP Conf. Proc. 1935, 110002-1–110002-4; https://doi.org/10.1063/1.5025996
Published by AIP Publishing. 978-0-7354-1627-7/$30.00

of the study. The participating students were allowed 40 seconds to write down the words associated with the key word, and then they were allowed additional 20 second to write a sentence explaining the concept. Content analysis method was used in the analysis process of the study. Following WAT, the data were analyzed in details on the basis of number of words and semantic proximity [11]. Consequently, the data having semantic proximity were used and the categories were distinguished accordingly. The final shape of the categories was decided on by consulting the opinion of an expert in physics education research.

FINDINGS

Following WAT administered to students, the data were analyzed and the words having semantic proximity were divided into seven categories. Table 1 shows the words collected in the study and the categories distinguished with those words.

TABLE 1. The Distribution of Students' Cognitive Structures about the Concept of "Work" according to Categories

Categories and Total Frequencies	Concepts in the Categories	Concepts' Frequencies
Mechanical Work (34)	Motion	22
	Acceleration	3
	Inertia	9
Definition of Work (95)	Force	56
	Direction	4
	Change of direction	6
	Distance	25
	Way	4
Work and Energy Connection (118)	Transformation	4
	Energy	72
	Joule	14
	Loss	6
	Gain	19
	Efficiency	3
Work and Power Connection (92)	Power	65
	Watt	4
	Time	23
Work parameters (11)	Mass	7
	Weight	4
Work as Job (107)	Working	20
	Endeavor	4
	Future	4
	Employee	9
	Business setup	3
	Career	3
	Profession	18
	Money	34
	High School	3
	University	3
	Tiredness	6
Examples of Work (4)	Boy with the box	4
Total	30 Words	461

461 words were collected through WAT. The first category distinguished following the analyses was "Mechanical Work" (f=34). The category consisted of the words "motion, acceleration and inertia". The second category was "Definition of work". This category, with frequency value of 95, was the category having third highest frequency. This category contained the words "force, direction, change of direction, distance and way". The third category, "Work and Energy Connection", was the category with the highest frequency in this study with frequency of 118. The fourth

category was called “Work and Power Connection”. The category, containing the words “power, watt, time” had frequency value of 92. The fifth category, with frequency of 11, was called “Work Parameters”. Students’ words “mass and weight” were included in this category. The sixth category having the second highest frequency with the value of 107 was called “Work as a Job. The words in this category were “working, endeavor, future, employee, business, setup, career, profession, many, high school, university and tiredness”. And the final category distinguished was “Examples of Work”. This was the category having the lowest frequency with frequency value of 4, and it contained only the phrase “boy with the box”. The sentences students had written in relation to the key concept of work were also analyzed and the categories distinguished are listed as in the following. When examined according to the number of sentences written and according to frequencies, the category of “Work and Energy Connection was the first (f=24), which was followed by the category of “Definition of Work” (f=20). The categories of “Work and Power Connection” and “Work Parameters”, on the other hand, did not have any sentences. The codes representing the relevant students were used in parentheses in the sample sentences given, and they are shown in Table 2.

TABLE 2. Students’ Sentence Examples in Categories

Categories	Sentences
Mechanical Work	“Work means being able to get distance”, (S. 36)
	“It is the case of taking action” (S. 21)
Definition of Work	“It is the multiplication of force applied with distance” (S. 3, 4, 16, 44, 94, 101, 115)
	“If force applied to an object can move it in that direction, it means work has been done.” (S. 47, 112)
Work and Energy Connection	“It is the movement we make by spending a certain amount of energy.” (S. 11, 24, 74)
	“Energy is necessary for work.” (S. 69, 78, 82, 128)
	“Work is the change of energy” (S. 70, 102, 118)
Work as a Job	“Work is an instrument to earn money”. (S. 124)
Examples of Work	“Simple machines make work easier.” (S. 49)

CONCLUSION AND DISCUSSION

This study aimed to determine students’ cognitive structures about the concept of work by using word association test. 136 participants wrote down 30 different words in this study. The words with semantic proximity were grouped and thus seven categories were distinguished. The categories distinguished were “mechanical work”, “definition of work”, “work and energy connection”, “work and power connection”, “work parameters”, “work as job” and “examples of work. The category of “Work and energy connection” had the highest frequency according to words and sentences it contained. Accordingly, it was found that students’ learning was generally at the stages of knowledge and comprehension. It was found that students could not distinguish the concept from differences used in daily life clearly. Physics teachers should attach more importance to concept teaching in order to be able to solve the problem. Including the drawing technique in research would yield better results in analysing students’ cognitive structures in more depth.

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