AN EMPIRICAL INVESTIGATION INTO THE RELATIONSHIP BETWEEN STUDENTS' COGNITIVE DEVELOPMENT AND COMPREHENSION OF PHYSICS CONCEPTS

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ABSTRACT

An Empirical Investigation into the
Relationship between Students' Cognitive Development
and Comprehension of Physics Concepts

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The objective of this study was twofold: (1) to investigate the comprehension of concrete and formal physics concepts by concrete and formal-operational students in the second secondary science stream; (2) to investigate the cognitive development of the same students using a paper and pencil instrument (the Longeot Test) for this purpose.

The sample of this study was comprised of 389 second secondary science students (209 males, and 180 females) of the school-year 1979-1980. This sample was drawn randomly from three public schools in the city of Irbid. Class was considered the unit of selection of the subjects from the target schools as follows; three classes were randomly selected from eleven classes at Irbid Secondary School for Boys (127 students); two classes were randomly selected from six classes at El-Ameer Hassan Secondary School for Boys (82 students); and all the four classes (180 students) at Irbid Secondary School for Girls.

The researcher classified the physics concepts covered during the first semester by the second secondary science students as either concrete or formal concepts. This classification was according to the definitions presented in the study. Then an achievement test consisting in its final form of 22 multiple choice items was constructed to measure the comprehension of the students on these concepts (11 items measure the comprehension of concrete concepts and the other 11 items measure the comprehension of formal concepts). The reliability
of this test was calculated, using KR-20, and found to be .69, the reliabilities of the subtests were also calculated by the same formula and found to be .50 for the concrete items as a subtest, and .55 for the formal items as the other subtest.

Cognitive development of the students was measured by an Arabic translated version of the Longerot Test, a paper and pencil group test. The calculated reliability for this instrument, using KR-20, was 0.94.

The achievement test in physics was administered to all second secondary science students at the three target schools simultaneously as it was their final examination for the first semester. The Longerot Test was administered to the sample of the study after the mid year break.

The study revealed that, regardless of sex, only a very small percentage of second secondary science students could function at the formal level of cognitive development, whereas the majority of the students could not function beyond the concrete level.

The one way analysis of variance did not reveal any significant difference between the three target schools in cognitive development as measured by the total score on the Longerot Test. Consequently it did not reveal any significant difference between boys and girls in cognitive development.

A 2 x 3 analysis of variance on each of the three dependent variables (comprehension of concrete concepts, comprehension of formal
concepts, and physics achievement in general) revealed that cognitive level was always a highly significant factor for all the dependent variables. Sex was not a significant factor in the comprehension of concrete concepts but it was significant in the comprehension of formal concepts and in physics achievement. The interaction between sex and cognitive level was not significant for the three dependent variables.

The pair-wise simple comparisons between the subgroups revealed that within sex, the higher the cognitive level, the better the comprehension of physics concepts (irrespective of the type of the concept) and the better the achievement in physics.

Further analysis of the data using a $10 \times 10$ matrix of correlation coefficients revealed that strong relationships exist between cognitive development, physics achievement, and comprehension of both concrete and formal concepts.