The Impact of Social Motivational, Cognitive, and Pedagogic Content Dimensions on Understanding Chemistry Concepts

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Abstract

The study examines the impact of social motivational, cognitive, and pedagogic content dimensions on understanding chemistry problems. Three groups of university students: freshman science college students, n (50), freshman inservice students' teachers n (45), Junior and Senior inservice students' teachers n(70), had been examined in understanding chemistry concepts. The results show that the social motivation, cognitive, and pedagogic dimensions have a great impact on understanding chemistry concepts; inservice junior and senior students' teachers who studied methodology course show the best understanding for chemistry concept; the results also show that inspite that freshman science college students had a higher score on General Secondary Exam upon admission, however, freshman inservice teachers show better understanding for chemistry concept in the test (both groups did not study methodology course).

Key words: Social, motivation, cognitive, pedagogy, content knowledge, chemistry problems.

1- Introduction

One of the important objectives of science education is to develop students' abilities to reason logically; such goal needs an understanding for the multidimensional of the problem that is: social motivational aspect, the pedagogy theory, the cognitive aspect, the core conceptual content, and the way to be represented.

1-1 Social Motivational Aspect

Vygotsky (1981) show that human conscious have their origins in human social life, deriving from internalized social relations that have become functions for the individual and form his structure; he postulated that mental functioning such as thinking reasoning, problem solving occurs first between people in social interaction, individuals' mental processes have specific organizational properties that reflect those of the social life from which they derive.

In the same aspect Gee (1991) pointed out that the mental structure of individual is not static, the social interaction has the greatest role in the dynamic process of learning which is represented in the transferring from verbal into written culture -solving science problems is part of such written culture.

Gagne (1976) considers that the motivation has a great role in learning process; it exerts its effects by a means of a set of expectancy established prior to the act of learning; activation of motivation appealing to student' interest leads to arousing attention.

Strike and Posner (1992) pointed out the importance of motivation and higher achievement in learning process, which is contracted with their previous point of view about static Piagean constructivist learning model.

1-2 Pedagogic Theoretical Aspect: Conceptual Change

Loughran et al., 2001 defines PCK as the knowledge that a teacher uses to provide teaching situations that help learners make sense of particular science content.

Shulman, L, 1987 states that pedagogical content knowledge represents the blending of content and pedagogy and how particular issue or problems are organized, the manner in which such content is communicated to student, and what is essential about subject and what is peripheral**;** Radford, (1998) show that PCK has been successful in improving the science content knowledge.

Stofflett, & Stoddart, (1994) consider conceptual change pedagogy to be important to get red from previous misunderstanding for learning experience. Yager (1991), stated that teacher education must involve conceptual change on the part of teachers, thus making the role of the teacher, as a facilitator of problem solving in science more crucial.

Gabel, Sherwood, & Enochs (1984) examine the problem –solving skills of high school students and concluded that one way of helping students overcome the algorithmic mode is to make certain that students understand the chemical concepts qualitatively before they are represented quantitatively.

1-3 Content Aspect -Crucial Conceptual Content in Chemistry:

Staver (1989) found that students harbor misconceptions about the mole that hinder problem solving, science textbooks fail to link the mole concept with the concept of standard number of particles, students believe that such concept is just associated with gram-molecule. Lawrenz (1986), show that fewer than 50% teachers responded correctly about mass relates to air , motion, and collision. Gabel, Samuel, and Hunn (1987) show that students have difficulties in understanding the properties of conservation of particles and the orderliness of particles. Gable, 1993 indicates that an emphasis on the particulate nature of matter led to an increase in the overall achievement scores. Bryan, & Abell, (1999) focuses on presentation of gas properties in terms of the qualitative-quantitative mode. They show that current pedagogic practice involves minimal use of qualitative relationships of the gas laws. Staver &Lumpe (1993) state that instruction should place greater emphasis on molecular representations and relate these representations to the macroscopic and symbolic level. Johnstone (1993) states that sub microchemistry involves particulate ideas, micro representational (symbolic), and mathematical manipulation, instruction must link the three basic representation of chemistry so that students work with a combination of the macroscopic, molecular, and symbolic representational modes.

1-4 Cognitive Aspect; Transition from Concrete to Formal

Ginns, & Watters, 1995 show that large percentage of adult individuals still function at the concrete operational level; this fact explain the reason that many teachers have misunderstanding of some scientific concepts. Lawson & Wollman, 2003, show that only 50% of adolescent and adult subjects of their sample were able to make affect transition to formal cognitive functioning; they examined the effect of instructional procedures that incorporate ideas designed and employed to successfully affect transition from concrete to formal cognitive functioning. The results of the study show that such approach encourage orientation towards problem solving, this fact is the outmost importance for educators. Lawson et al., (1989), point that reasoning by analogy, plays a central role in the formation of theoretical concept, the concrete operational level of thought for students would be activated in this way; students gained most when they were taught by teachers who were classified as concrete operational as opposed to formal operational.

2- The Problem

The multi dimensional aspects that educators should take into consideration to accomplish better results in teaching science had been reviewed. The study proposes that learning is a dynamic process that is affected by the change in expectation, in such a way, that in service students' teachers would have different aspect about learning from younger and little experience freshman students.

2-2 Sample and Procedure

Investigating the succeeding in solving chemistry' problems was examined on three groups of university students: freshman science college students, n (50), freshman inservice students' teachers n (45), junior and senior inservice students' teachers, n (70), in one of Jordanian universities. All students study general chemistry course in first year upon their admission. Inservice students' teachers study methodology course in their second year of admission. Students had been tested at the end of second semester of the academic year. The freshman students in Science College had been admitted directly to university programs; they usually had higher score in GSC (General Secondary Certificate) than in service teachers who had a diploma college certificate in teaching before being admitted to university programs (diploma equal 2 semesters of university courses).

Instruction in methodology course implies discussing misunderstanding of natural science concepts. The instruction depends on using analogy as a mediator for transition from concrete to formal understanding. The even distribution of particles in gas phase had been illustrated by analogy, that the same number of particles gets the same space regardless of their atomic mass; students would see that passengers should get the same distribution of seats regardless of their body mass.

2-3 The Instrument

The study used Symbolic Application Particulate chemistry test (SAP), that Dorothy Gable, 1994, had designed to define the conceptual level of high school chemistry teachers in U.S.A. This instrument consists of 30 questions of problem solving for 10 chemical concepts; density, mixture, conservation of matter, kind of reactions, mole, chemical reaction, solution, equilibrium, and pH, on three levels; Symbolic, Particulate and Application.

3- The Result

The data (represented in Table (1) show that inservice mature students' teachers who get pedagogic content knowledge about particulate nature of matter show the best understanding for chemistry concept (average 16.6/30= 55%) than freshman inservice teachers (13.55/30=45%) and freshman Science College Students (12.63/30=42%) . The results also show that the social motivation, cognitive, and pedagogic dimensions have a great impact on understanding chemistry concepts, inservice mature freshman students' teachers average made better than freshman College Science students (45%> 42%), in spite of being admitted younger and with a higher General Secondary Score. The results also show the importance of instruction that focused on introducing a pedagogy content knowledge to structure students' misunderstanding in core scientific concepts; inservice junior and senior students' teachers who get methodology course did better than freshman inservice students' teachers (55%>45%)

4- Conclusion

The result of the study shows that learning is a dynamic process affected by the social and motivational aspect; although freshman Science College students had been admitted younger and with a higher average on General Secondary Exam, however, their average score on problem solving chemistry test was slightly less than freshman inservice students' teachers (42%<45%); the results show the importance of the social aspect of the profession in changing teachers expectancy from science instruction.

The study also shows that restructuring student' conceptions in the core scientific concepts that have misunderstanding for it, would lead to better capabilities in solving scientific problems. The emphasis of instruction on making students represents the abstract concept visually through analogy could explain that effect.

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Table (1)

Students' group	No of students	Average	Percentile	Std-deviation
Freshman College students	50	12.63	12.63/30=42%	3.17
Freshman in service stud- tea	45	13.55	13.55/30=45%	3.75
Jun-senior in service stud-tea	70	16.6	16.6/30=55%	4