

# The Impact of Pedagogy Content Knowledge on Pre-service and In-service Students' Understanding and Solving Chemistry Problems

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## Abstract

*The study examined the impact of pedagogy content knowledge on pre-service and in-service student' understanding and solving chemistry problem. The sample consisted of 16 students pursuing a Bachelor degree in Educational Sciences College; 8 of them were pre-service, and the other 8 were in-service students' teachers who had two years diploma on teaching prior to their admission to university programs; the pre-service students had been admitted directly to the university (having a higher score on GSC -General Secondary Certificate). The whole sample studied general chemistry course in their freshman year and a methodology course in their junior year. The results show that although in-service students' teachers had been admitted with lower GS, however, they show better performance in solving chemistry problem. This indicates the dynamic process of learning and that the mental structure of individual is not static, integrating the practical science teaching experience with formal pedagogy content knowledge allowed better understanding for scientific concepts and in turn a better performance in solving chemistry problems on the part of in-service students' teachers.*

## 1. Introduction

Holding pedagogy content knowledge is a characteristic that is considered by Shulman as the one that distinguish teachers from content specialists. He considered that one of the important objectives of teacher education programs is to develop students' teachers' pedagogy content knowledge, which goes beyond knowledge of subject matter, to how to give the most useful forms of representation, the most powerful analogies and illustration in such knowledge; to have a good understanding to how a particular issue or problems are organized, the manner in which the content of subject matter is communicated to student, and what is essential about subject and what is peripheral; the alternative forms of representation for curricular material to be available for instruction; a good knowledge for the appropriate material to use, and how to sequence those materials to help students acquire new concepts [1].

Shulman also considered that PKC provides the teachers with the most regularly taught topics in a given subject area, and what makes the learning of those topics easy or difficult for students. Teachers should have an understanding for the nature of students' conceptions, their specific learning difficulties, the educational contexts, and the educational purposes for a given subject area [1].

## 2. Literature review

There are many theoretical approaches to deal with the way to represent the pedagogy content knowledge that is usually afforded in methodology courses:

### 2.1. Constructivist approach.

The Constructivists' theorists consider children's' ideas about the physical world is developed from birth; those ideas are characterized by being personally constructed [2,3]. Depending upon such view point, a great deal of research has been devoted to study alternative conceptions that characterized students' personal ideas about how the world works.

The constructivists considered that student' naïve ideas in the core concepts work as a critical barriers that hinder further learning in many other related fields, such naïve perceptions are characterized by having a high degree of coherency. The complex topics that were target of investigation in natural science are those related to particulate nature of matter, light, conservation of matter and energy [4, 5]. In this way, constructivists considered that the most important knowledge that students teachers should have is the way to get rid from previous misunderstanding of learning experience, thus making the role of the teacher, more crucial [6]. Conceptual change pedagogy is considered as an important issue to be involved in teacher education programs in teaching science contents; learning science content through conceptual change methods through in-service programs facilitated the development of understanding in science topics [2].

### 2.2 Sociocultural approach

The sociocultural approach as it had been illustrated by Vygotsky is focusing on the connections between people and the sociocultural

context in which they act and interact in shared experiences [7].

It is argued that meaning is made interactively, evaluation of knowledge is not absolute and objective, instead, it is sociohistorical constructs. Situated meanings are not static, rather, they are flexibly transformable patterns that come out of experience and adapted (contextualized) to experience in practice [8].

The constructivists approach had been criticized by New Marxist theorists for considering mental functioning as if it exists in a cultural, institutional and historical vacuum; they argued that constructivism is distancing education through distance students from their own perspective to induce cognitive conflict. There is a great effect of group membership on evolving sense of subjectivity through the continual interrelated processes of identifications [9, 10].

In sociocultural approach, the view of students as actors with fixed identity is replaced by more dynamic model of student behavior; efficacious pedagogy considered to be a judicious mixture of immersion in a community of practice; the most fruitful patterns in learners' experience is the one which represents the developing in a cultural models used by the community of practice to which the learner is being apprenticed [11, 12].

The Newbehaviorist theorists, who adopted sociocultural approach about the nature of constructing knowledge, consider that motivation plays an essential role in learning process; motivation exerts its effects by a means of a set of expectancy established prior to the act of learning; activation of motivation appealing to student's interest leads to arousing attention [13].

Motivation is considered as the internal state that directs students, behavior toward achieving certain goals, since it activates students' tendency to find academic activities meaningful [14].

In social-cognitive motivation framework, it is believed that students possess a self-regulating system that affect the development of motivation and their academic achievement; the self-determination is an important factor in this sense; when students believe they have some degree over their learning, motivation and in turn achievement are increased [15].

Within this frame work, Bandure considered self-efficacy "the beliefs in one's capabilities to organize and execute actions to produce given attainment", to be associated with science achievement, and that successful experiences lead to raise students' confidence [16].

**2.1.1. Previous researches.** Strike and Posner (1992) adopted the socio-cultural approach in their explanation for students' learning; they show that restructuring students misconceptions had succeeded

only with high achievement high motivated students [17].

Glynn, Taasobshiraz and Brickman ,proposes that characteristics of students such as career interest interact with characteristics of a specific learning environment such as a required science course to influence students' motivation to learn and achievement [14].

Wilson, Shulman, & Richert ,show that PCK growth is largely dependent on the motivation [18].

On the other hand, Pajares, , states that teaching experiences before entering an education program can undermine the influence that education courses that might have on changing students' teachers' beliefs [19]

Jong, et al., that integrating practical knowledge, and experience with formal pedagogic content knowledge had led to better capabilities in solving scientific problems [20].

Gable et al., show that students used to solve scientific problems depending upon memorizing algorithm without deep understanding the concept that underlie the scientific role; pedagogic practice usually involves minimal use of qualitative relationships [21].

On the other hand, Noh, Lawrence, and Scharmann concluded that while instruction with pictorial materials at the molecular level helped students construct scientific conceptions, however, such uses had no facilitating effect on problem-solving ability [22].

### 3. Research rationale

The study tried to examine the role of teachers' practical knowledge, as it constructed by teachers in the context of their work on solving scientific problems; it also tried to examine the succeeding of students' teachers' in integration their practical knowledge, experience and formal knowledge to accomplish such goal. The impact of pedagogy content knowledge that is offered to students' teachers in methodology course had also been examined.

The study tried to identify the effective strategies that could be implemented in teacher education courses to enable students' teachers construction of an accurate scientific concept; the study adopted Gable [21] view point in making students understand scientific concepts qualitatively before being represented quantitatively.

The study tried to identify the nature of students' teachers misunderstanding core chemical concepts; such misunderstanding, the study proposes would hinder their ability to comprehend other related concepts.

The study proposes that restructuring students' teachers' idea in the key chemical concept about

particulate nature of matter would allow better understanding for chemistry problems.

The study also proposes that the succeeding in restructuring students misconceptions is related to the past experience and motivation of students' teachers.

#### 4. Analysis of findings

The sample of the study was consisted of 16 teachers' students pursuing a Bachelor degree in Educational Sciences College, 8 of them were pre-service teachers without any previous teaching experiences, and the other 8 were in-service teachers who had a previous two years Diploma in Teacher Education from Junior Colleges. The pre-service teachers' students who had been accepted directly to University had a higher score on GSE (General Secondary Certificate). The whole sample studied a general chemistry course in their freshman year and a methodology course in their junior year.

Analysis of students' view point in essay test prior to instruction shows that students' teachers have misconception about the core concept of the mole; they believe that mole represents a mass property, not a number of particles.

Restructuring students' teachers' idea was depending upon letting them aware of their erroneous phenomenological view about particulate nature of matter. The even distribution of particles in gas phase had been illustrated by diagrams and analogy. They see that the same number of particles gets the same space regardless of their atomic mass; how an equal number of particles of substance A, have to reacts with equal number or multi whole number of particles of substance B, whatever the mass of each particle is. Students would see that passengers should get the same distribution of seats regardless of their body mass.

After instruction, students teachers had been testified using 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.

Table 1 shows that while pre service teachers had a higher score on GSE (General Secondary Exam), upon their admission to the program ( $80.75 > 63.01$ ), however, they have lower average score on SAP test ( $49\% < 56\%$ ); in-service students' teachers' average scores were higher on SAP test in spite of being having lower scores on GSE.

**Table 1. Results of score on GSE**

Students' group	Num of student	GSE	Stud' Average	Percentile	Standard deviation
Pre service	8	80.75	14.8	$14.8/30*100=49$	2.7
In service	8	63.01	16.9	$16.9/30*100=56$	4

These results show the importance of integrating practical experiences to pedagogic content knowledge, to better understanding of scientific concepts; in service students' teachers who integrate their fruitful past experiences with their pedagogy knowledge in methodology course had higher score on SAP test.

#### 5. Conclusion

The result of the study shows that learning is a dynamic process, human mental functioning does not exist in a cultural, institutional and historical vacuum; although young pre-service students' teachers had been admitted with a higher average on General Secondary Exam, however, their average score on problem solving chemistry test was less than mature in-service students' teachers ( $49\% < 56\%$ ).

The results of the study also show that the past experience of in-service teachers allows them to become more conscious of the better way to acknowledge their own expertness. In service students' teachers had been successful in integrating their past teaching experiences with their pedagogy content knowledge to get the highest score on SAP test.

The results also pointed out to the importance of motivation in learning process; in service teachers see the immediate effect of pedagogy content knowledge in their works which raise their motivation and attention to instruction.

The findings agree with the work of Jong, et al., [20], in that integrating practical knowledge, experience with formal pedagogic content knowledge lead to better capabilities in solving scientific problems.

The results also agree with Gagne [13] and Strike & Posner [17] works for the importance of motivation in learning process; in-service students' teachers who felt the immediate effect of pedagogy content knowledge on their works raise their motivation and paid more attention to instruction.

The result of the study also support Glynn, Taasoobshiraz and Brickman. proposition [14] that career interest could interact with a required science course to influence students' motivation and achievement .

On the other hand, the results of the study contracted with, Pajares, [19] proposition that teaching experiences before entering an education

program can undermine the influence that education courses might have on changing students' teachers' beliefs.

The results of the study support Gable et al., [21] view point for the importance of understanding the concept that underlie the scientific role before solving scientific problems.

On the other hand, the result of the study had contradiction with Noh., and Scharmann [22]) assumption in that although instruction with pictorial materials at the molecular level could help students constructing scientific conceptions, however, such uses had no facilitating effect on problem- solving ability .

In conclusion; the result of the study indicates the importance of the mature teaching experience and the motivation that students' teachers bring to classroom; these factors play greater role than a merely having previous higher achievement scores.

## 6. Acknowledgement

The SAP test that had been used to accomplish this paper depended upon the copy that had been sent to the author in the year 1996 via e-mail and regular mail from Professor Dorothy Gabel. Several researches had been done by the author in the past years using this instrument.

## 7. References

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