The implying of conceptual change pedagogy by in- service teachers

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Abstract
The study investigates the implying of conceptual change pedagogy by in-service teachers, unique cases of such implementation; and professional development in their career.
Data were collected from seven in- service teachers enrolled in methodology science course four years ago. Qualitative research method was used in analyzing data.
The results showed that conceptual change pedagogy was implied to overcome learning obstacles, enhance enthusiasm to further learning, raise the potential to solve every day problem, get rid of erroneous core ideas, such as the confusion in the function and processes of cell division, circularity system, living material, states of matter; where understanding those core ideas reduced the time to further re-learning on the part of their students ; using conceptual change pedagogy had enhanced professional development through allowing their students to organize information, making comparison, using refutation and dialectic discussion, and referring to evidences in their explanation to science ideas.

Key words: conceptual change pedagogy, in-service teachers, professional development, misconceptions, dialectic discussion.

Literature Background

The studies about misconceptions, followed the tradition of constructivists' theories: Posner, Strike, Hewson & Gertzog,1982, considered that naïve preconceptions, involve a belief system that prevent students' deep understanding of scientific concepts; conceptual change strategies go through dissatisfaction with currently held concepts, encountering new and plausible concepts, and accommodating the new concepts.

Krause, S., Kelly, J., Baker, D, 2011, states that students have prior knowledge about how phenomena work; still they may hold misconceptions about them; this leads them to neither explain nor predict how things work; and in order to deal with such issue; misconceptions must be identified and addressed through informed instruction; allowing students engage in social construction of knowledge and justification of responses. Hewson, & Hewson, 2003 considered that students' prior knowledge provides an indication about the alternative conceptions they possessed.

Another recent effect on students learning, the studies on misconceptions, had found, is the presence of a positive relationship between students' retention and their misconceptions; learners withdraw from further knowledge acquisition under the influence of preexisting misconceptions; as misconceptions affected students' enthusiasm and motivation towards fulfilling course requirement Chen, Sonnert, & Fredericks, (2019).

Still, Yasbec, Borovsky, &Kaschak, 2019, showed that although misconceptions put obstacles on students' learning; however, text style and epistemic beliefs had a positive impact on conceptual change and long term learning. Kowalski, and Taylor, 2017, used refutational text to correct misconception; the study showed that students recognized more correct concepts, retained them, and demonstrated higher verbal comprehension significantly more when taught by such texts.

Christon & Prokopon, 2020, used refutational text to help students disengage from their misconceptions. The results showed that such text helped them to overcome misconceptions that are related to revolutionary theory in history of science, retaining and generalizing them on everyday life situations.

Another source, the studies on misconceptions had found to affect getting rid of students' erroneous ideas, is the nature of scientific content; Lederman, Newsome & Latz, 1994 show that the complexity of subject matter structure is of a critical factor in classroom practice of conceptual change. Hewson & Hewson, 2003, considered that understanding the relationship between mass, volume and density of crucial importance to understand physical science. The study of Kikas, 2004 show that overcoming misconceptions regarding natural phenomena: the motion of objects, seasonal changes, and aggregate changes of matter, are very important to effective instruction.

The accumulation of research evidences about the influence of overcoming students' misconception on learning science, lead science educators to pay attention of implying conceptual change pedagogy in science education programs, in order to enhance professional development on the part of in service-teachers.

Greensfeld & Elkad-Lehman, 2007 showed that science teachers' professional development is context bound. Chen, Sonnert, & Fredericks, (2019) considered that knowledge of student misconceptions is important component of pedagogical content knowledge (PCK), and of crucial element of teacher's skill; students cannot correct their misconceptions by themselves over time, even if their teachers have solid subject matter knowledge, only students whose teachers have knowledge of student' misconceptions can achieve conceptual change.

Stofflett & Stoddart, 1994, Stofflett, 1994 indicated the importance of using conceptual change pedagogy in teaching science; they considered that such experience let teachers accommodate their preconceptions of science and undergo a process of pedagogical conceptual change themselves; through

discovering, the new strategies to be intelligible, plausible, and fruitful, with implicit dissatisfaction of their preexisting views.

Kang, 2007 examined teachers' epistemological and ontological understanding of teaching for conceptual learning, and the ways in which teachers applied their understanding of conceptual change pedagogy to their instructional practices; they showed that teachers used their ontological understanding to change the ontological nature of student ideas.

2. The Problem

Literature review showed how the presence of misconception affect students' learning of core scientific ideas; and the influence of using conceptual change pedagogy on overcoming their learning obstacles. This study tried to study the effect of training in-service teachers to handle their students' misconceptions. In service teachers were asked to respond by writing to three questions regarding whether:

A- In-service teachers used conceptual change pedagogy in their instruction after graduation (2016-2020).

B- The existence of unique cases that resulted of implementation conceptual change pedagogy.

C. In-service teacher's professional performances had been developed in the period (2016- 2020) due to the implementation' practices of such pedagogy.

2-1 Subjects of the study. The subjects of the study had been elected from in service teachers enrolled in Master Science Education Program, four years ago. There were seven in service teachers in the course (Nature of Science and the Methodology of its Teaching- the second term 2015/2016). The instruction addressed misconceptions using refutational evidences to challenge students' erroneous ideas.

In that course, the professor used to send the material of instruction to the manager of the class group by e-mail; the manager recycled instruction material to her classmates.

In the spring of 2020, the researcher contacted the manager of the class group to collect the research data from in- service teachers enrolled in course four years ago; the responses had been sent by e- mail during the ban of transportation last April.

Qualitative research method had been implied in collecting and analyzing data from in service teachers Journals.

3- The Results:

3-1 Responses to first question:

Have you used conceptual change pedagogy, which had been part of requirement of Master in Science Education Program, in your teaching? Tell your own feeling and the affect such method has, on your students?

In-service teacher 1:

Yes, I did use conceptual change pedagogy in my teaching. My students carry various misconceptions from previous learning experiences. I made my best to implement what I had learned during university training by:

a- communication - both oral and written;
b- addressing questions to uncover students' prior knowledge, during lesson's engagement, and before the discussion takes place;
c- listening to students' explanations of their conjectures when they are working collaboratively with their peers;

d- Asking questions during discussion in formal and informal way: such as "how do you explain what you observed?"

I tried to address and uncover all misconceptions and restructuring them before I moved on with the topic.

In-service teacher 2:

Yes, I used this method during my teaching science. I felt that this method had led to a meaningful learning on the part of students. The students gave evidences of their learning, by transferring their understanding to everyday life

In-service teacher 3:

I used to restructure students' misconception during my teaching biology; I had found that most of these misconceptions had been deepened in their beliefs since childhood. Students refer to their teachers at childhood as a reason of their misconceptions; their teachers did not have enough scientific background, in their training, to teach all essential subjects, including math and science.

In-service teacher 4:

After completing the Master in Science Education, and working as a supervisor, I tried to implement conceptual change pedagogy in my training to in- service science teachers; I felt that there is so much need to train teachers in discovering and restructuring their students' misconceptions.

In-service teacher 5:

As a teacher for 9^{th} grade physics, I found that emphasizing instruction on fundamental concepts is very important, since, in this way, we can deduce a lot of facts, and in the long run, increase students' potential to solve everyday problem. I found that using conceptual change pedagogy reduced the time for repeating instruction and re-learning the subjects on the part of students, during their transfer from one stage to another; since, in this case, students used to explain every day phenomena in scientific way; they also used to implement what they had learned to a lot of in-formal situation.

In-service teacher 6:

I found that restructuring students' misconception leads to increase enthusiasm on the part of students. It also leads to break the ice of instruction' routine; letting teachers concentrate on the core elements of subject matter; attract students to listen, and increase their interaction; this leads, in the long run, to enthusiast the process of learning.

In-service teacher 7:

During the course in Master program, I felt a lot of confusion; I noticed that I had a lot of erroneous ideas, that I was thinking as scientific ones; university training had a great impact on my teaching science at elementary stage; I tried to restructure students' naïve ideas with a lot of enthusiasm

3-2 Responses to the second question:

Give examples of unique cases that show how your students had been affected by conceptual change pedagogy.

In-service teacher 1:

Examples of such cases are:

a- Students were having misconceptions in biology thinking that mitosis is cell division. I showed students, in detail, the stages of cell division, in order to let them understand that mitosis is only one stage of cell division;

b- Students were thinking that the function of artery is only to carry oxygenated blood in the vessels of circularity system; they did not link such function to the function of glucose and the mitochondria in the cell. The function of mitochondria, for students, is just to *release* or *transfer energy* in the cell. I let students remember that energy cannot be created (or destroyed) from nothing, so mitochondria

does not "create" energy, the energy are released from what had been condensed in hydro carbonic bonds through photosynthesis;

c- Another misconception is that students confused between cell division and cell differentiation. I let students remember that cell *division* means the splitting of cells in halves, while cell *differentiation* means that different genes get expressed to let cells specialize to a certain job.

d- Other misconceptions students have, are their considering enzymes as a living material, died during the dying of the cell.

I let them understand that enzymes are large molecules inside cells', they are not, themselves a living material; so they can't die, they can only be *denatured*, and when the shape of the enzyme molecule changes, this leads to distort their active site.

In-service teacher 2:

First, I tried to restructure students' initial ideas; then, I collected evidences to be sure that the new information I had provided is plausible for students.

In-service teacher 3:

I taught students of elementary stages. I found a lot of erroneous ideas between students at that stage; they were thinking that plant gets their food from the soil; they did not differentiate between breathing and respiration, and between melting and dissolving.

I get rid from students' primitive ideas, using analogy.

In-service teacher 4:

In my work as a supervisor, I questioned school teachers about some phenomena, and discuss their explanation. Teachers discovered, by themselves that they had a lot of misconceptions, they need to adjust them. This fact had let them to revise a lot of their ideas, and to be sure that their students get the right ones.

In-service teacher 5:

I felt from my experience, that restructuring students' ideas had a lot of advantages:

a- Restructuring students' ideas decreases the difficulties students face in building scientific concepts.

b- Students became better able to give scientific explanation for phenomena and accurate prediction.

c- Students have more enthusiasm toward learning science; more potential to organize information, and making comparison between natural and biological situations.

d- Students had a better attitude to make discovery and contextualizing, which allowed solving problems.

In-service teacher 6:

I'm a biology teacher, and while I was teaching cellular respiration to seventh grader, I found that most students mixed between respiration and breathing (inhale Oxygen and exhale Carbon dioxide). I tried to get rid from such misconceptions by:

a- Introducing the essential preconceptions, such as, glucose, combustion, energy

b- Linking the work of respiratory system with the work of circularly system and digestive system.

c- Introducing the biological concepts, comprehensively in order let students understand exactly the function of respiration to the living organisms.

In-service teacher 7:

As a science teacher for elementary stages, I found that students at that stage had a lot of erroneous expressions concerning scientific concepts. For example, while I was teaching the state of matter to third grade students, I noticed that students used the expression "ice is **dissolving** by raising temperate" (instead of **melting**); I tried to change such erroneous expression by giving an example "when you were sad, and now are happy, do you change yourself? They respond "we're the same person, but in different state". I told them, this is the same with what happens with water, water is the same component by melting, but , with

different state; while in dissolving another material is situated itself between the empty spaces of water molecules. I tried then to be sure that students get the correct idea by addressing many questions.

3-3 Responses to the third question:

Has your method of instruction been developed in a way that changes your professional performance? Give examples

In-service teacher 1:

Yes, I did; with time, I became more confident and able to detect, and then implement strategies, to identify and remove misconceptions.

I had also used to introduce concept maps during my instructions.

In-service teacher2:

Yes, I did develop my profession; there were a qualitative jump in the way students developed their concepts; in the past, and pervious to using constructivist approach, when I show my students orange, and asked them to describe it, they used to say" it is a kind of fruit that we can eat it"; but after using constructivist' approach and conceptual change pedagogy; students say "orange smells good, so we can made perfume from its cover; oranges have a beautiful shape, that we can organize them in a beautiful geometric shape. We can discover the number of seeds inside. So, orange concept had changed from just a king of fruit that can be eaten, to a plant that can offered many advantages, varies according to the way student construct his concept.

I had developed my way of instruction, that as long as the concept that had been introduced is adjacent to students' feeling, student would be able to suggest better logical responses.

In-service teacher3:

I had developed the way of introducing scientific materials, especially in physics; instead of introducing them in abstract way, I tried to depend on concrete phenomena to make abstract physics concepts more comprehendible.

In-service teacher 4:

I had developed my way of supervision, in trying to give feedback to supervised teachers, and those in training projects, in dialectic way.

A lot of times, I felt the need to return back to my Journal, that I had developed during attending university courses, in order to bring examples, or addressing some complicated scientific issues.

In-service teacher 5:

My way of teaching had developed; I became more dependent on using conceptual map; such advice reduces the time to accomplish the goals of instruction in a flexible way.

Conceptual change pedagogy helped in correcting students' misconception, especially in making students at elementary stages differentiate in expression between dissolving and melting; and between plant production through seeds and through stems.

This method helped also in letting students induced and developed scientific concepts.

In-service teacher 6:

My way of teaching had developed; I stopped introducing the information directly; I know now that most students have erroneous information; I used brain storming and open discussion; I wrote students' answers on the blackboard, and then discussed them, until reaching to the more accurate one.

In-service teacher 7:

I developed my way of introducing information in becoming more depending on conceptualizing scientific ideas. When I teach periodic table for example, I let students know, what every number besides element stands for; I let students notice the trend of elements' properties in the same group and in the same period.

4- Conclusion:

In response to the first question of the study, in-service teachers, indicated that they had used conceptual change pedagogy in their teaching; and that such pedagogy leads to:

A. more communications between them and their students.
B. Students tend to give better evidence for their explanation.
C. Students became abler to transfer their understanding to everyday life, and in the long run, increase their potential to solve everyday problem.
D. Students become more enthusiastic toward learning, having better attitude to make discovery and contextualizing that allow them to solve problems.

These findings agree with the findings of other studies; Chen, et, all., (2019) show that using conceptual change pedagogy affected students enthuses and motivation towards fulfilling course requirement.

The results of the study also agree with the work of Krause, et all., 2011 in that students became more engaged in social construction of knowledge and justification of responses by overcoming their misconceptions.

In response to the second question of the study, in-service teachers pointed to the importance of getting rid of several of fundamental students' misconceptions as the confusion in the function and processes of:

A: cell.
B: circularity system.
C: living material.
D: states of matter.
E- Plant production
E- Respiration
F-Photosynthesis.

In service teachers indicated that part of students' misconceptions is due to misunderstanding scientific expressions. These results are identical with Kyle (1995) point of view, who states that scientific language is hard on students to grasp, which led, in the long run, to misconception on the part of students.

These findings agree with the findings of other studies; Chen, et, all., (2019) show a presence of a positive relationship between students' retention of learning and overcoming misconceptions; the results also agree with the work of Lederman, Newsome & Latz, 1994 who show that the complexity of subject matter structure is of a critical factor in classroom practice of conceptual change..

In responding to the third question of the study, that tried to investigate whether conceptual change pedagogy had led to professional development on the part of students' teachers: In-service teachers considered that conceptual change pedagogy helped in allowing further professional development on their career in:

A. Eliminating the need for further re- learning on the part of their students.
B. Having better attitude to inquire about their teaching success.
C. Helping students' teachers in deducing a lot of facts.
D. Inquiring the gap in their students' learning and their initial knowledge structure of representation.

E. Allowing more comprehensible representation instead of representation that lacks coherence.
F. Having better skills in organizing information and making comparison using concepts map.

These results agree with work of Kang, 2007 that shows that teachers' applied their epistemological and ontological understanding of conceptual change pedagogy to their instructional practices.

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