DO PRE-SERVICE SCIENCE TEACHERS HAVE UNDERSTANDING OF PEDAGOGICAL CONTENT KNOWLEDGE? *

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Abstract

The purpose of this preliminary study was to investigate pre-service science teachers' understanding of pedagogical content knowledge (PCK) that can support them in the teaching and learning of science at Bahrain Teachers College in Bahrain. The following preliminary study questions were attempted:
To what extent did pre-service science teachers display understanding and learning of science in terms of PCK?
To what extent did pre-service science teachers integrate their content knowledge and pedagogical knowledge to plan, design, and conduct science lessons?
The use of strategies such as visual modeling, computer simulations, and animations, hands-on and minds-on activities to make the learning meaningful in science were examined. The data for this preliminary study were obtained from samples of pre-service science teachers' journaling, lesson plans, two initial surveys, and semi-structured interviews in order to probe pre-service science teachers' understanding of PCK in science education. It appears that the construction of PCK is complex and pre-service science teachers need to have some basic understanding of PCK in order to teach science effectively.

Keywords: *content knowledge, pedagogical knowledge, PCK, science*

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INTRODUCTION

One of the most important factors contributing to student achievement and high quality education (Barber & Mourshed, 2007) is the quality of teachers (Darling-Hammond, 2000). An effective and efficient way of enhancing teacher quality is to improve the content knowledge and pedagogical skills of pre-service science teachers (Gopinathan et al., 2008).

Content knowledge consists of knowledge of science concepts, relationships among these concepts, and methods of acquiring the knowledge (Etkina, 2005). Shulman (1987) described it as the structure of knowledge - the theories, principles, and concepts of a particular field, and skills that students learn. Shulman (1986) also posited a specialized knowledge that distinguishes teachers from subject matter specialists is pedagogical content knowledge (PCK).

The pre-service science teachers should have a broad and updated understanding of major content areas of science (Wenning, 2007). They must have accurate understanding of the processes of science which are related to the Nature of Science (NOS). Teachers need to master both content knowledge also known as deep knowledge of the subject matter such as physics or chemistry, and also knowledge of the curriculum development that is teachers plan guides learning. (Shulman, 1987).

Pedagogical knowledge is a representation of the "generic why and how to" of teaching (Wenning, 2007). According to the National Science Teachers Association (1998), pedagogical knowledge consists of "actions and strategies of teaching, organization of classroom experiences, providing for diverse learner needs, evaluation and implementation of learner's prior notions, and transformation of ideas into understandable pieces." The pre-service science teachers should have a comprehensible understanding of the following as seen in Figure 1 as parts of pedagogical content knowledge according to the PCK framework (Wenning, 2007; Abell et al., 2009; Padilla et al., 2008; Nilsson, 2008; Henze, Driel, & Verloop, 2008; Berry, Loughran, & Driel, 2008; Loughran, Mulhall, & Berry, 2008; Hudson & Ginns, 2007; Appleton, 2008; Rollnick et al., 2008).

There is a connection between content knowledge and pedagogical knowledge in science teaching (NSTA, 1998). For example, teachers know about "organization of classroom experiences" (NSTA, 1998). But to design such "organizations" requires a deep understanding of content knowledge.

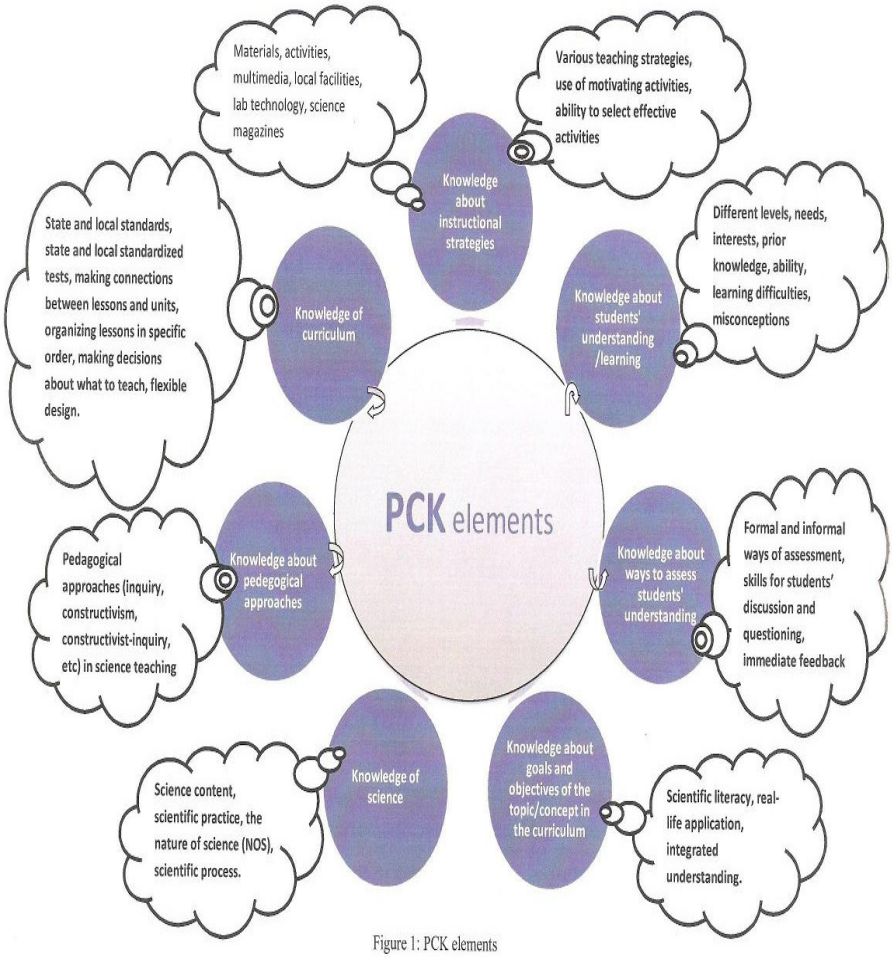


Figure 1: PCK elements

Shulman (1987) affirmed this view stating, "the key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy." Why is pedagogical Content Knowledge (PCK) considered an essential tenet in Science Teacher Education? PCK is defined as "a nexus of both content and pedagogy into a form of knowledge that comprises representations of analogies, illustrations, examples, explanations, and demonstrations so that content is understandable to students" (Piccolo, 2008). In other words, this close interconnection between subject matter and pedagogy in teaching (Ball & Bass, 2000) is necessary so that students can understand the content knowledge better. Pre-service science teachers need to have a combination of content knowledge and pedagogical knowledge to gain better conceptual understanding of science and to transmit this effectively to their learners. (An, Kulm, & Wu, 2004).

Thus the agenda for effective science teaching consists of an amalgam

of content knowledge for teaching science, pedagogical knowledge, and pedagogical content knowledge. All pedagogical competencies and understanding of them are based on having a deep and comprehensive understating of science content (Piccolo, 2008). If we aim to change science learning and understanding, we must start with science teaching. This requires establishing standards around PCK as an essential tenet to make improvements in science teaching (NSTA, 1998).

SIGNIFICANCE OF THE STUDY

Pre-service science teachers should have an extensive and current understanding of the major content areas of science, pedagogical knowledge of science teaching, and integration of content and pedagogical knowledge (PCK) in science teaching. Thus, "what pre-service science teachers know and are able to do can be grounded in what their future students need to know and are able to do in order to live in and contribute meaningfully to life in a society" (Wenning, 2007).

In attempting to examine and trace pre-service science teachers' understanding of content knowledge, pedagogical knowledge, PCK can give valuable insights to both policy makers and science educators in terms of understanding and developing the nature of science education.

THE PURPOSE OF THE STUDY

The purpose of the study was to investigate science pre-service science teachers' understanding of PCK that can support them in their teaching and learning of science.

The preliminary study questions addressed in this study were:

To what extent did science pre-service science teachers display understanding and learning of science in terms of PCK?

To what extent did pre-service science teachers integrate their content knowledge and pedagogical knowledge to plan, design, and conduct science lessons?

METHODOLOGY

Participants in this preliminary study were 25 pre- service science teachers (one male and 24 female) who were in the one - year PGDE (Post-Graduate Diploma in Education) programme in Science Education for Secondary level. They took three courses related to science teaching approaches as their programme requirements. These were as follows:

The first semester (Fall 2008): Teaching and Learning in General Science 1(25 pre-service science teachers), Teaching and Learning in Biology 1 (9 pre-service science teachers), Teaching and Learning in Chemistry 1(16 pre-service science teachers)

The Second semester (Spring 2009): Teaching and Learning in Biology 2 (9 pre-service science teachers), Teaching and Learning in Chemistry 2 (16 pre-service science teachers).

25 pre-service science teachers took two surveys during the first semester. Three pre-service science teachers involved in this preliminary study also volunteered to participate in interviews to elicit information about pre-service science teachers' views of their own teaching. This was an important way of encouraging pre-service science teachers' reflections on their own teaching practice (Nilson, 2008).

Data Collection

Over the course of a year, the three pre-service science teachers' had been teaching Chemistry or Biology at the secondary level as part of their teaching practice requirement. The choice of subject depended on their specialization. Because of some constraints, observing pre-service science teachers and video-recording of pre-service science teachers' teaching practice were not possible. Therefore, data collection included semi-structured interviews with regard to their teaching and lesson plans, pre-service science teachers' journals, and two initial surveys with 25 pre-service science teachers.

The semi-structured interviews were conducted to investigate the pre-service science teachers' understanding of PCK. The interview questions were developed on the basis of results of studies of the relevant literature on PCK. In the context of pre-service science teachers' lesson plans; they were questioned about the elements of PCK listed as seen in Figure 1). All interviews took place privately in the office with pre-service science teachers' consent. The interview took 30 to 45 minutes for each pre-service science teacher.

Data Analysis

Data obtained from the semi-structured interviews were analyzed in order to have information of pre-service science teachers' reflections on their understanding of PCK and teaching of science by integrating content and pedagogical knowledge. All interviews were transcribed verbatim. Data were analyzed in terms of examples of reflections related to PCK and those that might have the potential of the development of pre-service science teachers' understanding of PCK. The analysis focused on the elements of PCK.

The first and second surveys were administered in the first semester, Fall 2008 to explore pre-service science teachers' initial understanding of some elements of PCK. The questions were about strategies, approaches, etc. As listed based on the literature, there were several elements of PCK, but in this preliminary study the analysis focused on the most commonly acknowledged knowledge bases. These were knowledge about instructional strategies, knowledge about students' understanding and learning, knowledge about

ways to assess students' understanding, knowledge about goals/objectives of the topic in the curriculum, knowledge about pedagogical approaches.

RESULTS

1. Surveys (Open-Ended)

Some questions as follows were asked to elicit science (Chemistry and Biology) pre-service science teachers' understanding of some elements of PCK. Names used were pseudonyms.

What are some of the strategies, concepts, approaches you have applied during teaching practice in terms of teaching and learning science (biology, chemistry, or physics)?

How do your students learn science topics?

Table 1: *Results of Surveys*

Instructional Strategies	Pedagogical Approaches	Students' Learning/ Understanding
• Traditional-paper and pencil • Group work • Power point slides with pictures • Smart board- • Concept mapping-helped to manage lesson plan • Cooperative learning • Discussion in the group • Brainstorming • Experiments • Group working (interpersonal intelligence) • Visual learning (visual intelligence) • Using animal toys • Classification games	• **Brainstorming and group discussion** • **Models-pictures-drawing** • **New technology** • **Models, flashes** • ***Inquiry*** • **Illustration** • **Concept maps** • **Flowcharts** • **Movie clip** • **cards**	• Discussion • Solving problems • Doing some experiments • Read textbook • Memorize • Group work • Visual learning • Asking questions to students • Textbooks • Taking notes during classes • Labs • Solving exam/test questions • Real life examples-make connections to real life with examples • Doing homework • Experiments • Brainstorming • Experiments • Active learning

As seen in Table 1;

* Pre-service science teachers had some knowledge about various teaching strategies and materials used to teach science such as toys.

* However, pre-service science teachers had mixed knowledge on how

students learn and understand science topics with instructional strategies. For example, pre-service science teachers had a misconception of students' learning/understanding. They thought that visual learning was an instructional strategy to teach science. Visual learning focuses on students' learning.

* The section on pre-service science teachers' knowledge about pedagogical approaches to teach science was disappointing because it seemed that they did not have any clue about pedagogical approaches. This was because they did not have any background in classroom pedagogy. Their background was in science- chemistry or biology.

2. Interviews

Semi-structured interviews were held with three volunteer pre-service science teachers as a preliminary study to probe their understanding of pedagogical content knowledge because pre-service science teachers did not know how to apply these approaches as part of PCK due to their lack of their understanding of the elements of PCK. So, interviews were required to elicit their understanding of these elements of PCK. Interview questions were developed on the basis of the results of studies of the relevant literature on PCK and the results of the two surveys conducted during their PGDE programme; all questions were related to the classes they taught in their teaching practice at secondary schools.

Some of the questions in the semi-structured interviews were as follows:

1. In what activities and in what sequence did your students participate in the context of this topic/chapter (eg. Metallic bond)? Please explain your answer.
2. Did your students need any specific previous knowledge in the context of this topic/chapter? Explain your answer.
3. How did you deal with your students' questions?

With these questions pre-service science teachers' understanding of PCK was probed. Their answers to these questions were analyzed by classifying them into appropriate groups such as knowledge about instructional strategies and knowledge about students' understanding and learning which are elements of PCK.

2.1. Afaf's Understanding of PCK

Topic of her lesson: Metallic Bond

Knowledge about instructional strategies: Afaf's instruction in Metallic bond included several activities which were simulations, concrete examples from real life such as electric wires, cooking containers, and spoons. Visual tools were also used in the class. In addition, she used a PowerPoint presentation, asked students to create concept maps related to metallic bond. She also used several beads as seen Figure 2 to demonstrate that the atoms can move from one place to another and still remain in contact with and bonded to the other atoms and electrons around them.

Figure 2. *Beads to demonstrate the movement of atoms.*

She said (she taught this topic during teaching practice) that these electrons can move easily from one place to another, allowing for good electrical conductivity. To a limited extent, the atoms can also move from one place to another and still remain in contact with and bonded to the other atoms and electrons around them. I (she) will use these beads to represent atoms. If these are shifted in position, the atoms still remain in contact with one another. Although the external shape of the metal is changing, the internal pattern is the same. Thus the shape of metals can be changed.

The topic was abstract for this level students so she decided to choose different activities to get her students to comprehend the topic of metallic bonds.

"I know this level of students who are in their 15s, 16s, or 17s. They cannot imagine abstract things. What I said them there is ion and electron near to ions and these electrons are easily move it is difficult to imagine what happens because of that after I explained to them, I see that it is not clear for them by showing that flash (animation) they said that it is like that. So I know there is not all of the students can catch the idea and imagine the metallic bonding how can be between ion and e^- but by showing them the flash and giving concrete examples and they can understand easily."

"I bring them some real samples which are made of metals and make them to, for example, aluminum try to break it they cannot because it is very solid. But when another spoon made of, for example, another metal which is easier to break it, bend it and then from that I asked them questions. Why is the difference? Aluminum is metal. Why is difference? Why we cannot break this one but we can break this one? And then I started concept I wanted to teach, there is metallic bonding between atoms I discussed the metallic bonds. And then I showed them because it is imaginative concepts. We cannot imagine how e^- come out of the atom this becomes positive ion and e^-, are surrounding to them so e^- has freely movement. So I showed them flash from internet (flash =animation, simulation).

She seemed to have an understanding of what is meant by 'instructional strategies 'with regard to metallic bond content mainly based on her students' responses to her lesson, indicating their motivation, abilities, and understanding. She stated that real life examples, materials and animations enhance students' understanding of the content of metallic bonds.

Knowledge about Students' Understanding and Learning: She was aware of her students' prior knowledge by asking some questions which were related to this topic of metallic bonds as seen in her lesson plan as per pre-activity (Table 2). She stated that her students needed electro configuration to understand metallic bonds and they already had this prior knowledge.

Table 2. *A part of the lesson plan on Metallic Bond (Pre-activity)*

Pre-Activity

Time allocated	Instructional Stage	Teacher/Students Interaction	Rationale	Resources
5 min	-Teacher begins lesson by giving revision of previous lessons.	T: What are the types of bonds? S: Ionic and covalent bonds. T: Well done! T: ionic bonds occur between what? S: Metal & non-metals. T: Excellent! T: and covalent bonds? S: Non-metals and non-metals. T: very good!	Teacher to assess students' prior knowledge.	
	-Teacher gives feedback about NaCl and its bonds (ionic bonds). -Then teacher asks students attractive question about metal bonds to start the lesson.	T: You know that NaCl compound take this shape because of ionic bonds. However, this sodium metal is one metal. What makes it looks like that? What makes metal atoms still together? Let's see.	Motivate students and Engage them in the lesson by asking attractive question.	NaCl compound Na metal

Afaf: Yeah. e^- configuration to understand how a metal should lose e^- to get stable.

I: Did you provide this previous knowledge or did they have it?

A: They already have because they were taught this subject before. So, they will understand this topic because it is easy for them too. I ask students to make e^- configuration on the board, they did, I didn't do that.

She was also aware that not all students understand the concept in the same way. Their understanding and learning levels were different.

"Yes, students did not understand in the same way. Sometimes, they don't understand in one way and when explain in other way, they understand. For example, when you ask questions to students, you see there is no one raised hand. You know you should change the type of question, and when you changed the type of question and level of question, the number of hands increase, it means not one type of question you can use, you should differentiate between questions and your students can understand what you want and give some time to think about the answer."

"What I see from my experience, they like something to use, touch and to see visual."

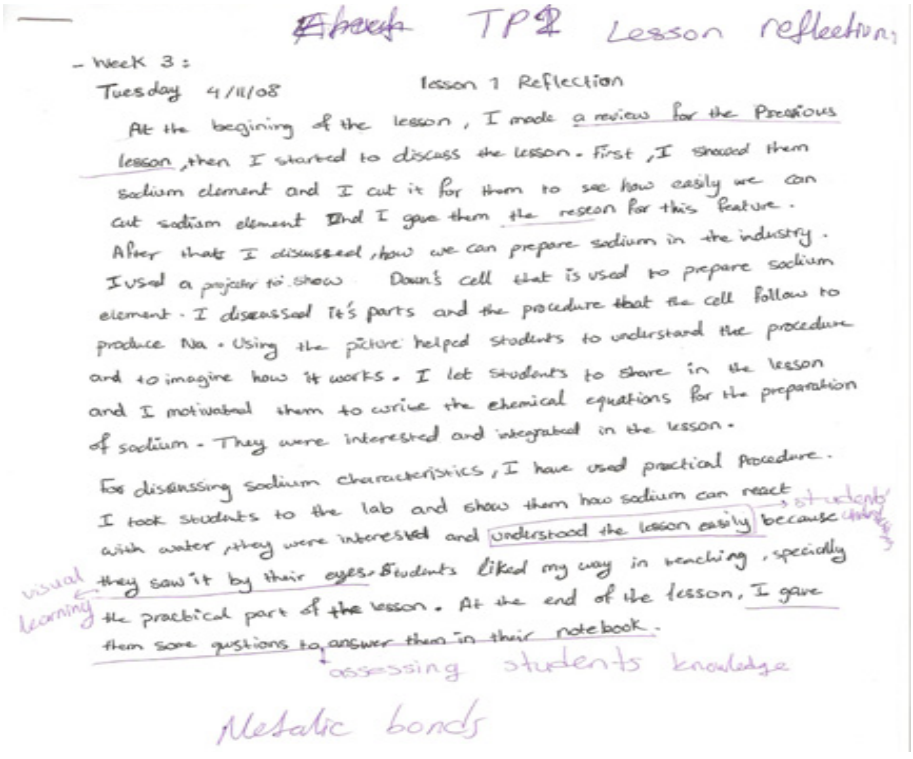
"Not all of them, some of them like chemistry, most of them didn't like chemistry they say it is boring there is nothing to see and many materials. But when I use

activities I see they become more in the lesson interest, so they need lesson need to be changed not the material. You should put some activities because if you give concept it will be boring for students so it is in the way of giving of content not in the content."

Afaf seemed to develop her knowledge about students' understanding and learning by observing their work and asking questions in the classroom as part of her instruction and making the classroom student-centered.

I think it was easy for students to understand it. Because I tried to make what I can explain each concept for example also to explain them metal they can change their shape easily by heating you can change their shape. I bring to them this one this experiment to them. This is positive ions, they are connected together (beads are used to do experiment in Figure 2). I asked them to imagine that my finger is force. How can we change the shape? I pushed them they change in the shape, but they stooped together,. So they get the concept we can change the shape but we did not break the metallic bond.

Two activities and animation. Also I show them sodium atom. I did this lesson experiment in the lab because sodium atom is very dangerous it cannot be found in the air because it will react and make very big fire. So I showed them how we can easily cut sodium atom, I showed them sodium atom because they did not know what is sodium atom what is the shape of sodium atom, and I showed them easily cut it. And they become amazing oo we can cut it. Because aluminum and iron difficult for them or cut them. But sodium atom is very easy to cut. So I cut it. I give them some caution before use sodium, because it is very dangerous they can burn themselves. Don't touch it don't bring water on it. I showed them how to cut it.


TP2 Lesson reflection:

- Week 3:

Tuesday 4/11/08 lesson 1 Reflection

At the begining of the lesson, I made a review for the Precedious lesson, then I started to discuss the lesson. First, I showed them sodium element and I cut it for them to see how easily we can cut sodium element. And I gave them the reseon for this feature. After that I dismussed how we can prepare sodium in the industry. I used a projetor to show Down's cell that is used to prepare sodium element. I discussed It's parts and the procedure that the cell follow to produce Na. Using the picture helped students to understand the procedure and to imagine how it works. I let students to share in the lesson and I motivated them to write the chemical equations for the preparation of sodium. They were interested and integrated in the lesson.

For dismissing sodium characteristics, I have used practical procedure. I took students to the lab and show them how sodium can react with water, they were interested and understood the lesson easily because they saw it by their eyes. Students liked my way in teaching, specially the practical part of the lesson. At the end of the lesson, I gave them some qustions to answer them in their notebook.

visual learning

students' curiosity

assessing students knowledge

Metalic bonds

Figure 3. *Afaf's reflection on Metallic Bonds lesson*

Knowledge about Ways to Assess Students' Understanding: She assessed students' understanding of the topic of metallic bond by asking some questions related to the topic and asking students to create a concept map to show the relationship among concepts.

"By asking them some questions after each point to evaluate them whether they understand or not. Because if you say them whether they understand they will say yes, but if you ask them questions you will know whether they understand or not. Another evaluation concept map at the end of lesson." (See Figure 4)

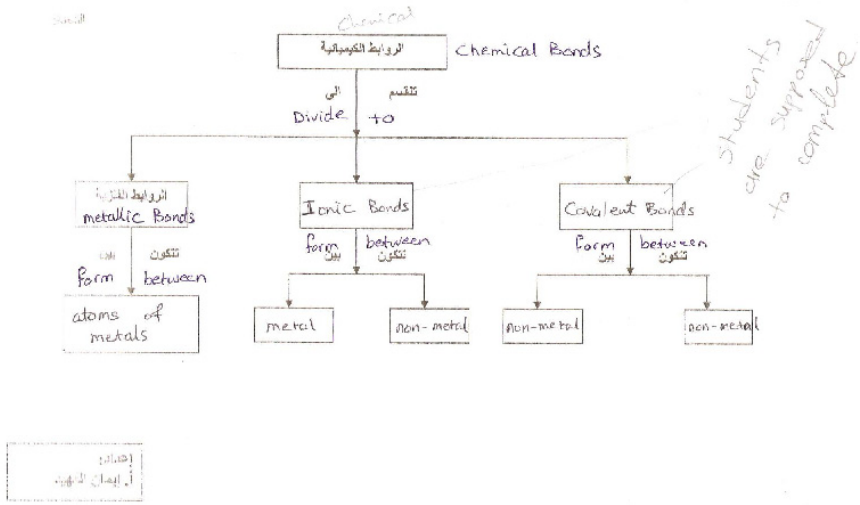


Figure 4. *Concept map of metallic bonds*

Knowledge about Goals/Objectives of the Topic in the Curriculum: She seemed to understand this aspect of PCK which includes scientific literacy, real life application and integrated understanding. She stated the main objective in teaching the topic of metallic bond:

To make students understand how metals we can use them for example in electricity conducting electricity, and metallic bonding. We can explain those we see it in the real life.so we can make connections to our daily life.

She stated that as her students reached the learning goals, she was satisfied with the results of her lesson:

From their (students) answers of my questions. My learning goals were to discuss to know what is metallic bond, how metal can conduct heat, how they can change their shape, and how they can conduct electricity.

Knowledge about Pedagogical Approaches: Afaf held some misconceptions about understanding of pedagogical teaching approaches. She thought that instructional strategies were teaching approaches. For example, she said she used cooperative learning as a teaching approach whereas it is an instructional strategy. In other words, she used guided inquiry in her lesson to teach metallic bond.

… most of my lessons I used cooperative learning strategy…According to their exam results, I distributed them into groups. Each group should have excellent, very good, good, low achievement students. So they will help each other. Not all high level students in one group or not all low level students in one group. Other strategy I say to them you have specific time to finish the activity and I will ask anyone in the group it is similar to hit together strategy to make sure that every member in each group know how to answer this activity and they teach each other. If I ask one group and they didn't know the answer the point will move to the other group. And I tell them that each 3 points you lost you will lose 1 mark. So it will make them motivation to finish first time and same time and the leader of the group teach the lower level to reach the point.

2.2. Mariam's Understanding of PCK

Topic of her lesson: Ionic bond

Knowledge about instructional strategies: Mariam's instruction in ionic bond had several activities which included simulations, cartoons,

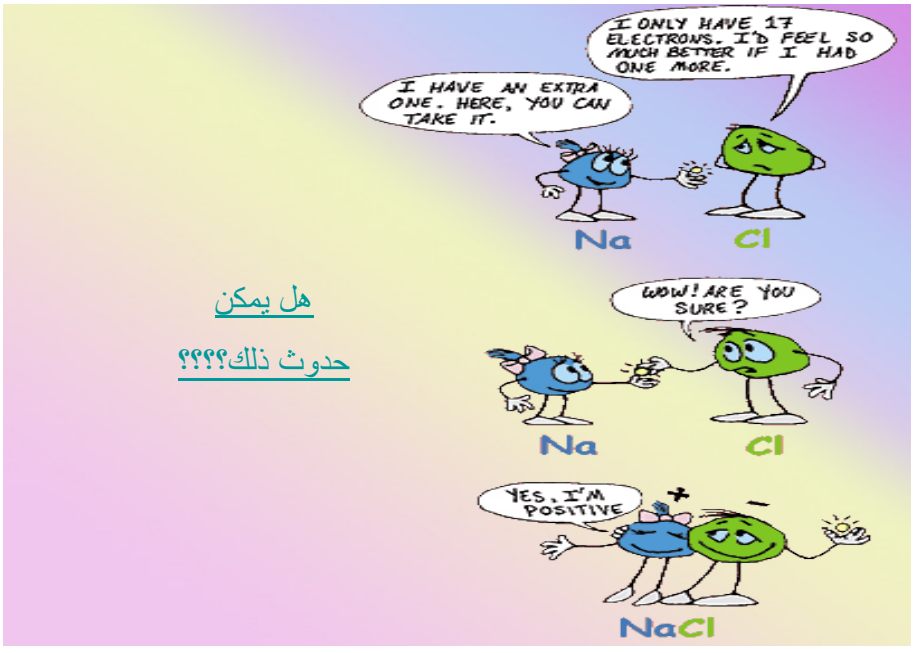


Figure 4. *Cartoons on Ionic Bonds*

Concrete examples such as sodium chloride (NaCl) known as salt, visual tools applied in front of the class. In addition, she used a PowerPoint presentation. For her teaching of Ion Bonds, she used simulations to show how Na and Cl attract each other and make an ionic bond.

As a pre-activity, she started by asking questions related to how atoms of various elements can chemically bond together to form compounds. She showed some pictures for Na, Cl, NaCl, and Cl2) and asked:

"why sodium chloride, which is salt, is not de-composited to chloride and sodium that is stable."

She also divided the class into groups and asked them questions to solve.

I prepare to my lesson by making adequate plan to met my objective also I prepare activity which is worksheet about ionic bond and I explore for different teaching strategies for example discussion about example related to the real life like why sodium chloride not decomposition to sodium atoms and chlorine, display PowerPoint slide which contain video and flashes , atoms story which related to topic and group work to ensure that all student can understand the topic even if they are less capable students. Also I need tow lesson to cover all material and activity for diverse students. (Journal, TP2)

Knowledge about Students' Understanding and Learning: She was aware of her students' prior knowledge by asking some questions which were related to this topic of ionic bond to elicit their prior knowledge. She stated that:

Yes, of course, for example they must know atom, atomic number, electronic configuration, and atomic structure, this Lewis dot structure because it is important. I put it as a part of my lesson. But it must be a prior knowledge to make the link between what was taught earlier (the known) to the new information (unknown).

So, she found that her students needed prior knowledge about atomic structure, e configuration, and Lewis structure.

Students have some difficulties about how to apply ionic bond by Lewis structure how to bond take place. They should have prior knowledge to be able to continue my lesson, but some students or many students, they didn't have prior knowledge. They should have had strong background knowledge to complete my lesson. I must flashback. I ask them about Luis structure about electron configuration which is basic. Maybe this is basic topic they have chem. 101 this is basic in chemistry. But it seems they forget everything.

Since the topic, ionic bond was abstract for these level students. She decided to choose different activities to enable her students to understand the atomic bonds.

Because atomic bond is not related to students life, but I come and give examples to simplify this topic, they became related to their life, for example salt they use salt in every day in their kitchen and everything and their food. I also give them story and they really like story. I think CT tell me you are wonderful in this topic you can simplify I have been teaching this topic 20 years I have some difficulties to give this topic to my students, I think you give students got understand this topic.

She was also aware of their students did not understand in the same way. Their understanding and learning levels were different.

Yes of course because our students are different we have 30 students have many differences. One group of students gave me attention understand by story. One of my students told teacher I can understand if you only write on the board specific things more important things on the board. I always write on the board if they are major things. I like this because I always understand by this.

Another student maybe in terms of learning, learning types of my students, I have different types of learning they have. So I have visual, auditorial I have so I research information I don't collect only flash movement I also search video which has talking, and voice to gain their attention. Also I have another student who I think they like doing things. so they are very interested when I give them to do.

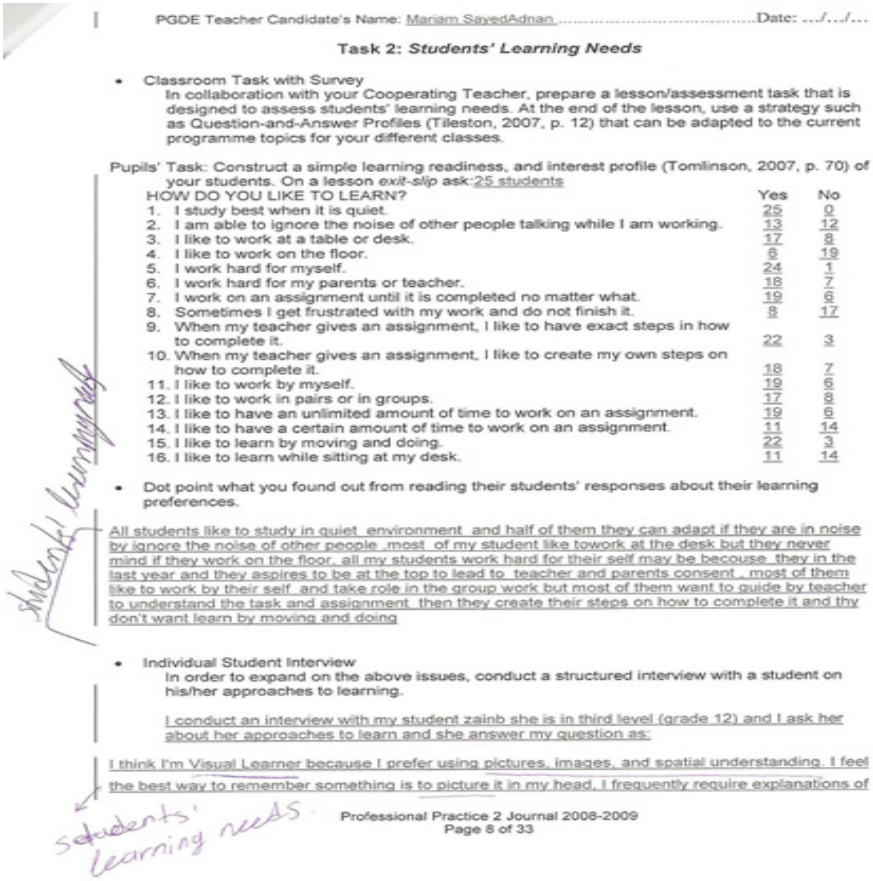
I think most of students they like commercial studies they want to go to commercial studies and told me why you are chemistry teachers we did not like chemistry yes most of my students do not like chemistry. But, at the end of my TP they said to me we little bit like chemistry

Because we now understand more things why chemistry is important by linking to their life.

From her journal (self-reflection), she stated that teachers should know their students' learning styles. So, she had an understanding of her students' learning and understanding.

Teachers should assess (know) the learning styles of their students and adapt their classroom methods to best fir each students' learning style, visual, auditory and kinaesthetic.

She administered a survey on students' learning needs and interviewed one of her students about that as part of her TP2. This survey gave her some knowledge about her students' learning needs (see Figure 5).



PGDE Teacher Candidate's Name: Mariam SayedAdnan .....Date: .../.../...

Task 2: *Students' Learning Needs*

- Classroom Task with Survey
  In collaboration with your Cooperating Teacher, prepare a lesson/assessment task that is designed to assess students' learning needs. At the end of the lesson, use a strategy such as Question-and-Answer Profiles (Tileston, 2007, p. 12) that can be adapted to the current programme topics for your different classes.

Pupils' Task: Construct a simple learning readiness, and interest profile (Tomlinson, 2007, p. 70) of your students. On a lesson *exit-slip* ask:25 students

HOW DO YOU LIKE TO LEARN?	Yes	No
1. I study best when it is quiet.	25	0
2. I am able to ignore the noise of other people talking while I am working.	13	12
3. I like to work at a table or desk.	17	8
4. I like to work on the floor.	6	19
5. I work hard for myself.	24	1
6. I work hard for my parents or teacher.	18	7
7. I work on an assignment until it is completed no matter what.	19	6
8. Sometimes I get frustrated with my work and do not finish it.	8	17
9. When my teacher gives an assignment, I like to have exact steps in how to complete it.	22	3
10. When my teacher gives an assignment, I like to create my own steps on how to complete it.	18	7
11. I like to work by myself.	19	6
12. I like to work in pairs or in groups.	17	8
13. I like to have an unlimited amount of time to work on an assignment.	19	6
14. I like to have a certain amount of time to work on an assignment.	11	14
15. I like to learn by moving and doing.	22	3
16. I like to learn while sitting at my desk.	11	14

- Dot point what you found out from reading their students' responses about their learning preferences.

All students like to study in quiet environment and half of them they can adapt if they are in noise by ignore the noise of other people ,most of my student like towork at the desk but they never mind if they work on the floor, all my students work hard for their self may be becouse they in the last year and they aspires to be at the top to lead to teacher and parents consent , most of them like to work by their self and take role in the group work but most of them want to guide by teacher to understand the task and assignment then they create their steps on how to complete it and thy don't want learn by moving and doing

- Individual Student Interview
  In order to expand on the above issues, conduct a structured interview with a student on his/her approaches to learning.

I conduct an interview with my student zainb she is in third level (grade 12) and I ask her about her approaches to learn and she answer my question as:

I think I'm Visual Learner because I prefer using pictures, images, and spatial understanding. I feel the best way to remember something is to picture it in my head. I frequently require explanations of

Professional Practice 2 Journal 2008-2009
Page 8 of 33

Figure 5. *Survey on students' learning needs (from teaching practice)*

Knowledge about Ways to Assess Students' Understanding: She assessed students' understanding of the topic of ionic bond by asking some questions related to the topic and giving them a quiz.

I give them at the end of lesson I gave them simple quiz because this lesson take two periods two lessons. At the last time of lesson 2 I gave them quiz. Quiz how to apply chemical bonds by Lewis structure.

Quiz and discussion, what we do, I ask them especially weak students I chose weak students to ensure that these students understand,

She stated that she wanted to use various assessment types-new assessment types for her-such as performance projects and authentic assessment to know how her students had been progressing throughout each semester and each year. (Journal, TP2)

Knowledge about goals/objectives of the Topic in the Curriculum: She stated that her students reached the learning goals so she was satisfied with the results of her lesson:

I think yes, because when I give them quiz most of them got full mark. No time to ask them more about their understanding. But when I gave them her paper, they started to say you know we started to like little bit chemistry we chose to study commercial studies I don't like chemistry.

To know how to illustrate this between two atoms. How to relate or ask why salt is not decomposition.

I think most of students reached main objectives. Because when I explain this topic at the end of this lesson, and asked them, do you know why this salt not decomposition without any outer condition? They answered the question correctly saying that because chemical bonds ionic bonds between chloride atom and sodium atom.

Knowledge about Pedagogical Approaches: She did not have an understanding of pedagogical approaches as revealed in her journal entries:

I grouped my students in group and I rotate student roles in group each time and I give students instruction and recall this instruction to become clear for all students also I use verity (various) of teaching approaches by using discussion, display flash and other. (Journal, TP2)

I grouped my students in five groups and always I rotate student roles in group work and I give students instruction and recall this instruction to become clear for all students also I use variety of teaching approaches by using discussion, display picture, video, flashes and group work. (Journal, TP2)

It seems she talked about teaching approaches (instructional strategies) such as video instead of pedagogical approaches. So her understanding of pedagogical approaches was missing.

2.3. Aisha's Understanding of PCK

Topic of her lesson: Hearing pathway-biology

Knowledge about instructional strategies: Aisha's instruction in hearing pathway included several activities which were pictures, movie clip, worksheets. In addition, she used a PowerPoint presentation, asked students to create concept maps related to the hearing pathway. Based on her learning experience, she decided to choose different activities to get her students to learn the topic of the hearing pathway.

Because me. I learn more when I see things. Become more relevant and more clear for me when I did something I get experience. And when I get experience then I don't forget what I learned. What I want my students learn the way I learned. Activities are practical things. Students participate or engage activity and by doing that practical things they gain experience and we learn from it.

First I used the brainstorming. Then I relate this to light transformation and after that the students come to idea how to the electricity come and the light open how this happened and then this will be connected what the topic that is ear. I use pictures and then ask students make first of all I divided into small groups. I gave each group different activity. First group I gave pictures I asked them make correct order. The second-I gave them paragraph with missing word. I give them words and then I ask them put them in order. The third I gave them pictures. Ask them According to the pictures, how the hearing occurs the ear picture. The forth group I asked them to make

concept map and I give them concept word and how can you use these words to make concept map.

After that, what each group did. After discussion in the class, explain to all student how the hearing occur, the other groups should evaluate or assess this group is correct or not what is correct answer. And we reach the best way how the hearing occurs. This is about hearing how the hearing occurs. And then I use video..video about hearing. I showed them movie clip how hearing occurred. Where is sound how is converted to sound waves how is converted to vibration and something like that,. Sound is transfer that we can hear. All this about the movie talk about students understand that. After students I assess students understanding. I use pictures without details I picked a student randomly and asked them to put details on the picture. After that I use hang man game. and I distributed questions to students, according to question students should pick one question and read we have letter by letter to complete this game.

She seemed to have an understanding about instructional strategies with regard to the hearing pathway content mainly based on her students' responses to her lesson, indicating their motivation, abilities, understanding, and construction of knowledge. She stated that using real life examples, materials, and practical things enhanced students' understanding of the content of the hearing pathway.

Knowledge about Students' Understanding and Learning: She was aware of her students' prior knowledge by asking some questions which were related to this topic of hearing pathway to elicit their prior knowledge. She stated that her students already had prior knowledge.

She was also aware that not all students understand the concept in the same way. Their understanding and learning levels are different.

A: *After one month, I understand how they want to understand. Because I used questioner about their needs. This questionnaire from the journal. I used it. I looked what students want to learn how they want to learn.*

I: *What are all the questions about in the survey?*

A: *Most of the students want to work into groups, and most of them want to move around when they are learning. They don't want teacher to tell or teach them all things, they want to discover they want to have practical things to do. They don't want many homework. The homework they wanted due date not.*

…there is students different. I ask the question in a way. I found that some of students don't understand. When I ask raise your hand. I found that half of class understand others not. I change this question in easy way or I relate this question to their life so they can understand when I see most of students and raise their hand and want to answer questions so I said now they understand.

She knew that her students' interest was to learn more about their bodies which is related to biology.

I teach science students majors science. Their major biology and chemistry. Biology they love biology and they hate physics. They like biology more than chemistry. Because biology is related to their life and their bodies more than chemistry. And they want to learn more about their bodies.

Aisha seemed to develop her knowledge about students' understanding and learning by observing their work and asking questions in the classroom as

a part of her instruction and making the classroom student-centered.

In addition, she used self-reflection to find whether her students understood the topic. Although self-reflection was a new concept for her, she was able to employ it in her teaching.

A: *I included something new for them which is reflection. I want each in class write reflection self-reflection about my lecture if they understand or not.*

I: *What do you mean by self-reflection?*

A: *After each class, the students should write what did they learn, did they learn or anything did they understand anything from that lesson. Is that lesson beneficial to them if it is beneficial how can they apply in their life.*

She used task differentiation that demonstrated she acquired knowledge of her students' learning and understanding abilities.

A: *I make first brainstorming then the activities for the task differentiation and then I concluded by again conclusions.*

I: *What do you mean by differentiation?*

A: *Task differentiation, You put students in groups. And then I give each group each group contain heterogeneous students who have different abilities and the group has high ability I gave them activities that are high, the group has low ability I gave them activities that are low. About the activities. This is the task differentiation.*

I divided students into 5 groups. Each group is with 5-6 members. I gave each group different task to solve it. The tasks are: constructing a concept map, matching the concept with its function, picture description, fill in blank and putting pictures in a correct order.(TP)

Knowledge about Ways to Assess Students' Understanding: She assessed students' understanding of the topic of the hearing pathway by asking some questions related to the topic.

Knowledge about Goals/Objectives of the Topic in the Curriculum: She seemed to understand this aspect of PCK which includes scientific literacy, real life application, integrated understanding. She stated the main objective in teaching the topic of the hearing pathway:

The goal for this lesson was that students should identify different parts of the ear and how the hearing takes place.

She stated that her students reached the learning goals so she was satisfied with the results of her lesson:

A: *I observe their participation, their engagement in the activities, their enthusiasm.*

I: *Did you ask any question during this teaching or group discussion?*

A: *I take round I asked them questions this questions may be guide them correct answers, because they did not read topics and they took the topic in the middle school long time ago, maybe they did wrong answer, when I ask them and clarify stg to some point to them they may reach the correct answer.*

A: *The students participate. This is social skills between them. They know each other they play and they enjoy they understand what they did.*

I: *How did you know they understand?*

A: *Because when they speak or talk about hearing there is confidence in their answers and there is great cooperation between them.*

Knowledge about Pedagogical Approaches: Aisha held some misconceptions about understanding of pedagogical teaching approaches. She thought that instructional strategies were teaching approaches. For example, she said she used 5E teaching approach and said it was an instructional strategy.

CONCLUSIONS AND IMPLICATIONS

This preliminary study considered how pre-service science teachers understood some aspects of PCK. The knowledge about instructional strategies pre-service science teachers have could facilitate their teaching. The pre-service science teachers acknowledged that these strategies (mostly activities, demonstrations, and animations, and movie clips) helped them link these strategies to their own instructional goals and strategies. This knowledge ultimately enabled the teachers to bring the scientific world outside of the classroom to the students and make science accessible to students.

Pre-service science teachers in this preliminary study commented on their students' learning and understanding styles, their prior knowledge, abilities and learning difficulties. They came to know their students' learning needs, preferences, and styles. These were essential in the decisions pertaining to their choice of instructional strategies. When pre-service science teachers stated and wrote about their lessons, they had a tendency to link their lessons to the goals of their science classes. One common goal among all teachers was teaching science to students so that they better understood natural phenomena in everyday life.

Pre-service science teachers tried to use a variety of assessments to ascertain students' understanding and learning of science concepts. These were quizzes, asking questions during group discussions, etc. Pre-service science teachers seemed that they have not yet had a clear picture of what knowledge of pedagogical approaches are.

This preliminary study indicates the importance of engaging science pre-service science teachers in projects with the main focus on reflection on their own teaching of science. This is to help them develop their understanding of science teaching and learning as expressed in the PCK (Dejong, van Driel, & Verloop, 2005; Nilsson, 2008).

RECOMMENDATIONS

"Videotaped lessons are useful ways of helping pre-service science teachers unpack the complexity of the classroom and promote opportunities for careful reflection on their teaching and reflection is crucial." (Nilsson, 2008). Therefore it will be very useful to observe and videotape these three pre-service science teachers (now they have been already appointed to teach in schools by the Bahrain Ministry of Education)' teaching of science classes as future directions of this research. It will be a follow up case study with these

three science teachers. Pedagogical approaches should be more emphasized in science teaching method courses. One module on assessment and evaluation should be offered to PGDE students especially they were struggling to understand what is meant by authentic assessment since their assessment types mentioned were mostly conventional pen & paper type.

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