Self Reflection Focusing On Pedagogical Content Knowledge

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Abstract

This article reports the findings of self-reflection among Chemistry student teachers which focuses on their pedagogical content knowledge. In the study, Chemistry student teacher were taught by lecturers and cooperative teachers to perform reflection and to identify critical episodes for several topics including chemistry syllabus, significance of the topics in chemistry, students' learning difficulties, teaching methods and assessment techniques during the teaching practice. The qualitative study was conducted among purposely selected 15 Chemistry student teachers. Data were collected through interviews, journal reflections and analysis of documents using their lesson preparatory books. The data were triangulated and analyzed using content analysis technique. The findings showed that the number of issues reflected by training teachers in the early stages of chemistry teaching practice were few. Furthermore, they only focused on general and descriptive issues. However, prior to guidance provided by lecturers and teachers, it was discovered that reflections on issue-based pedagogical content knowledge had increased and became more critical.

Keywords: Reflection, Chemistry Student, Teacher, Pedagogical Content Knowledge.

1. Introduction

Many educational researchers agree that the practice of reflection is one of the most critical components in a teaching program (Zippay, 2010; Pollard et al., 2008; Howard, 2003; Zeichner and Liston, 1990). It is considered as a process of careful and deep thought of all actions and acts performed whether planned or not (Goethal, 2004) and the ability to focus the thinking in dialogue with themselves about what they do (Hatton and Smith, 1995). Therefore it is necessary to inculcate the practice of reflection in each trainee teacher in order to help them implement a critical analysis of issues which can hinder the process of effective teaching and learning (Davis, 2006; Loughran; 2010; Lai and Calandra, 2010).

According to Schon (1987), reflective practice should be implemented in all stages of the teaching process. He has proposed two levels of practice reflection namely; reflection-on-action and reflection-in-action. Reflection-on-action refers to the practice of reflection done before and during the implementation process of teaching and learning. While reflection-in-action involves the practice of reflection that occurs after the teaching and learning process . Clarke (2008) states that effective teaching will only be produced by carrying out a critical reflection on teaching goals, teaching methods and students' ability levels. Through this process, teachers can identify the mastery of the subjects presented, the practice of teaching, students' learning styles and take the initiative to discover alternative strategies to overcome the encountered difficulties. Hence, failure to implement reflection practices can affect teachers' professionalism and students' learning performance.

However, conducting comprehensive reflections to all major aspects in teaching and learning processes are not easy. Therefore, teachers are advised to reflect on critical episodes that occurred within the implementation of the teaching process. Critical episodes are events, problems or issues that prevent the implementation of teaching and learning process to run smoothly and effectively. Selections of the critical episode rely heavily on teachers' ability to identify priorities in their teaching process. Studies conducted found that teachers often choose to critique on general episodes, such as problems in classroom management, student discipline, objective of teaching and others (Zembal-Saul et al., 2000). However, in constructive approach, the teacher is responsible for ensuring that students are able to understand the contents of education and able to assimilate existing knowledge with new knowledge acquired.

Therefore, studies were conducted to help teachers, especially chemistry student teacher in choosing critical episode which focused on one of the components of pedagogical content knowledge of science. Magnusson et al., (1999) explains that there are five key components of pedagogical content knowledge of science, namely (a) orientation to the science teaching, (b) knowledge of the science curriculum, (c) knowledge of students' understanding of specific science topics, (d) knowledge of assessment in science and (e) knowledge of science teaching strategies for science teaching. For Loughran et al., (2006), Henze et al., (2008), Drechsler and Van Driel (2008) mastery towards pedagogical content knowledge of science can help teachers present effective and meaningful teaching and learning process to students. In contrast to reflecting on the whole process of teaching which may include issues which disrupt the process of teaching such as disciplinary problems and time management, reflections which focus on components in the pedagogical knowledge of science content will indirectly assist chemistry student teachers to identify weaknesses and potential of the process of teaching and learning . Therefore this study identified issues reflected by chemistry student teachers in early stage of training sessions and after being guided by lecturers and cooperative teacher.

2. Methodology

Fifteen chemistry student teachers were purposely selected for this qualitative descriptive study which employed multiple case studies design. Data were collected at two different cycles. First was Cycle I which comprised of 1-5 weeks of teaching practice. Second was Cycle II which consisted of 6-12 weeks of teaching practice. Identification of reflective practice in Cycle 1 was based on the understanding of chemistry student teachers as a result of exposure given through lecture sessions during Micro Teaching and Teaching Methodology courses. However Cycle II involved reflection practice of chemistry student teachers which was guided by lecturers and cooperative teachers that focused on pedagogical content knowledge of science. The findings were gathered through document analysis of teaching preparation books, interviews and reflective writing journals. Subsequently, the data were analyzed using content analysis techniques. In addition, the results of this study are compared with related literature.

3. Findings and Discussion

Based on the analysis, it was discovered that chemistry student teachers reflected on two categories of issues; 1) the issues concerning pedagogical content knowledge of science and 2) the issues of a general nature (refer to Table 1).

Table 1. Percentage of issues raised by trainees' chemistry teacher

Reflected Issues	**No**	**% of Cycle I**	**Nol**	**% of Cycle II**
Pedagogigal content knowledge of science				
1. Chemistry Content	134	9.31	172	11.94
2. The Important of Chemistry Topic	8	0.57	52	3.61
3. Students Difficulties	43	3.07	205	14.24
4. Teaching Method	94	6.71	297	20.63
5. Assessment Technique	17	1.21	112	7.78
General Issues				
1. Class Management	88	6.11	11	0.76
2. Time Management	53	3.68	2	0.14
3. Fasility	21	1.46	1	0.07
4. No Reflection	150	10.42	7	0.49
Total	**611**	**42.43**	**829**	**57.57**

3.1. Issues Based on Pedagogical Content Knowledge of Science

Issues that were reflected by chemistry student teachers based on pedagogical content knowledge category can be divided into five core elements which are chemistry content, the important of chemistry topic in life, student's difficulties, teaching strategies and assessment techniques.

3.1.1. Chemistry Content

In the first cycle, the findings showed that nine per cent (9.31%) of respondents presented issues related to chemistry content. Here are some examples of writing obtained;

> *Teachers are very nervous when teaching*; *teaching becomes not organized and unstructured because teachers do not fully master the concept of electrolysis*. (Rin)

In addition, relevant issues also emerged in the analysis of journal;

> *I think I was very weak in teaching chemistry, mastery of Form 4 chemistry topic and is very weak. I have not very skilled in certain topics such as electrochemistry, salts and more. I'm so not confident when teaching and nervous with student questions because of afraid that question cannot be answered. I am ashamed to ask the mentors. But I tried to teach. (Uddin)*

On the other hand, in the second cycle, for similar category, the percentage increased to twelve percent (11.94%). Here is an example of writing obtained;

> *Teaching is not very smooth*. *Teachers do not make adequate preparation to teach the type of salt* that *is soluble and insoluble*. *Teachers themselves have yet to master these types*. *Class messy and most students do not fully understand what had been delivered, students* sit *behind a bit noisy* and *just students sit in front who focus on teachers teaching. Teachers make sure it will not be repeated*. *It should be read and discussed with other teachers before teaching*. (Ila)

Based on the above examples, most of the chemistry student teachers reflected on chemistry content. Chemistry student teachers realized that they were lack of mastery in chemistry topic content. The same findings were found in the study by Sherman et al., (2008) on the effectiveness of on-line program developed by the National Science Teachers Association. It was discovered that in the early stages, most teachers were not fully confident to teach science topics as requested. This notion indicates that most teachers do not master the content of science topics.

3.1.2. Importance of Chemistry Topics

The findings indicate that in Cycle I only 0.57 per cent of the respondents presented issues related to the importance of Chemistry topics. These issues are significant in order to clarify the application of those topics in the real world and everyday life. The following excerpts are examples of reflection on the above matter;

> *Students cannot give an example of uses in life without referring to notes. (Atie)*
> *Students easily understand when the teachers show an example. (Ila)*

The examples above are reflections of chemistry student teachers towards the class discussions on importance of chemistry in daily life. The same findings were found in the study by Loughran et al., (2006) who conducted a research in Australia. A small proportion of trainees teachers reflected on this issue to clarify the application of

science concepts in everyday life in order to motivate their students to become more aware of the application of chemicals in everyday life.

In addition, the total percentage of the issues raised in this category increased to 3.61 percent in Cycle II. The result was probably due to the guidance provided by mentor teachers and lecturers. The following is an excerpt pertaining to the issues;

> *It is difficult for teachers to tell students about the pH scale of acids and bases. Students were confounded. Maybe this class is the weak science class. But when given an example as measure of shirts for each person whether male or female, thin or fat is different, it appears the students showed interest in studying this concept in earnest. Teachers need to make sure before delivering a chemistry concept; teachers need to find what is close to student use so that learning becomes more meaningful. (As)*

Based on the above example, it is clear that with guidance and assistance from lecturers and cooperative teachers, the chemistry student teachers were able to identify their weaknesses in terms of emphasizing the importance of chemistry topics during the implementation process of teaching and learning chemistry. Similarly, Duffy (2009) who conducted a survey among student nurses found that the presence of guided based reflective practice on pedagogical content knowledge with the preceptor was successful in helping students to reflect deeply and critically. This notion is also being certified by Freese (2006) who found that by enhancing his role as a mentor and a *critical friend,* trainee teachers were able to do their reflections on teaching and thus managed to improve their teaching performance.

3.1.3. Students'Learning Difficulties

One of the critical issues reflected by the chemistry student teachers was students' learning difficulties . It is considered as one of the steps to ensure that students are able to explore the actual chemistry concept. Subsequently, 3.07 percent of the issues raised by chemistry student teacher in Cycle 1 revolved around students' difficulties to understand the Chemistry concept. Here are some examples of the issues;

> *Students confused by the concept of teachers delivered. (Aby)*
> *Students are still vague about what teacher's teaching. (Ayu)*

The above excerpts highlight the reflections on students' difficulties to master presented learning. However, the issues presented by the chemistry student teachers are not specifically on the chemistry concepts being taught. This is due to the lack of knowledge regarding students' weaknesses chemistry concepts . A similar situation was reported by Keles et al., (2010) who conducted tests on ninety two future science teachers and found that most of them also had misconceptions on several topics in science. As a result, these teachers were unable to identify difficulties faced by students and this weakness needed to be addressed through the guidance of mentor teachers and lecturers.

This notion was supported by the results in Cycle 11. There was a surge in the percentage of available issues in the second cycle. The percentage increased from 3.07 percent in cycle I to 14.24 percent in Cycle II. Here is an example of the issue;

> *From the experiments were carried out, students can observe the electricity produced through the voltmeter readings, but students are not able to explain how electricity is produced by cell. This was due to students not able to imagine and see the electrons are released and received as well as*

the electrons move. Teachers need to show a simulation for students to electricity production. Teachers will find that simulated either through the internet or CD-ROM that is supplied by the Ministry Of Education. (Azni)

The above scenario indicates that guidance provided by lecturers and cooperative teacher was able to provide awareness among chemistry student teachers on the importance of difficult aspects to be emphasized in teaching and learning. Hume and Berry (2010) found that chemistry student teachers who were given guidance in the performance of chemistry teaching and learning based on the framework of pedagogical content knowledge of science called CoRe were constantly strive to improve their knowledge on students' mistakes in chemistry topics and subsequently searched for effective strategies to address students' understanding of the problem.

3.1.4. Teaching Method

The study found that a total of 6.71 percent of the issues raised by chemistry student teachers in Cycle I focused on teaching methods. However, reflections on the issues rose to 20.63 percent in Cycle 11. The issue of teaching methods are divided into two categories; teaching strategies and teaching aids. An example of the excerpt on teaching strategies is;

Teachers need to call the students' name to answer the questions given than asking students to answer voluntarily. (Ibah)

In addition, the above matter was also highlighted in the reflective journal of one trainee chemistry teacher;

I find that I have problems in communicating or teaching. Although understand the topics to be taught, but I do not know how to communicate to students. I did not have good skills in teaching (Ayu)

Reflections on teaching methods include matters concerning teaching strategies employed on students, clarity of explanation , the use of visual or diagrams and also teaching methods in the laboratory. However, the descriptions presented were merely descriptive since the chemistry student teachers unable to reflect on the issue critically. It was due to their lack of knowledge on effective teaching strategies in the teaching and learning process. This finding is in line with Muhammet's (2009) study which found that most student teachers who underwent teaching training sessions were still unable to master the teaching method for a specific subject.

However, in Cycle II, due to the guidance provided by mentor teachers and lecturers, the percentage of issues raised by chemistry student teachers on teaching methods increased to 18.40. Here is an example of the issues presented in Cycle II;

All students have difficulty in solving numerical problems involving acids and bases molarity. In the next lesson, the teacher will give examples that easier to understand and solve easily. Teachers will guide them to solve the given problem. When they were able to solve the given problem, the teacher will give examples that more difficult. (Aya)

The above example shows that the chemistry student teachers had taken the initiative to reflect on her teaching methods by identifying weaknesses in them and worked on how to overcome the problems. Similar to the earlier findings, the increase in terms of percentage obtained in the second cycle might be due to the efforts done by mentor teachers and lecturers who stressed on pedagogical content knowledge, especially in the methods of teaching chemistry topics. Similarly, the study conducted by Park and colleagues (2010) also found that when a science

teacher recognized the importance of a specific teaching method for delivering a scientific concept and strive to improve his knowledge, indirectly the teacher would be more likely to reflect on teaching method.

3.1.5. Assessment Techniques

An assessment process based on pedagogical knowledge of science content is important to reflect on students' understanding about the presented concepts (NSES, 1996). But in Cycle I, the study found that only 1.21 percent of the issues raised by chemistry student teachers were on assessment techniques. Here are the excerpts;

> *Students are provided with exercise based on the textbook before class ended. (Atie)*
> *Intervals word activities to help students remember the words for what they have learned (Rin)*

This finding indicates that the chemistry student teachers put less emphasis on the issue of evaluation in their reflections. Thus the examples presented above illustrate the use of evaluation techniques by chemistry student teacher which were less able to diagnose students' weaknesses in the topic. This might be due to lack of mastery assessment techniques by chemistry student teachers to identify levels of students' understanding. A study conducted by Wang et al., (2010) also confirmed that most trainee teachers were still weak to understand the true concept of assessment in science learning. Trainees found to be less able to determine the domain to be assessed and the criteria needed to measure students' learning progress. Therefore, it is important to know the students' understanding.

However, there was a change in the finding for Cycle II. After the chemistry student teachers were given reminder and guidance by lecturers and cooperative teachers, the study found that reflected issues by chemistry student teachers pertaining to assessment of learning and teaching process rose to 7.78 percent. Here is an example of the proposed issues;

> *Assessment activity done at the end of class, that is students activity to answer the questions provided are not running smoothly. Teachers are too focused on a few students to ask questions and provide time to explain in detail how to answer questions to the students. This caused other students bored and a lot of time has been used without realizing that many more students who cannot solve the problem. Teacher will change the way of conducting the activities, teachers will answer students' questions in front of all classes so that all students are able to get attention properly. (Ida)*

Through the above example it is clear that the trainee chemistry teacher with the help of mentor teachers and lecturers was able to reflect based on pedagogical content knowledge and also able to identify students' weaknesses. Hence, students' understanding after the learning process could also be measured. This result is consistent with the findings by Harford and MacRuaicr (2008) who conducted studies on 20 trainee teachers in Ireland. They found that trainee teachers could adopt more critical reflection with the help and support through teaching video discussion with an expert teacher and guidance. In addition they were also given assistance based based on a specific reflection model.

3.2. General Issues

Findings showed that general issues category recorded the total percentage of 21.94 percent. Issues in this category are divided into several parts consisting of class management, time management and facilities.

3.2.1. Class Management

The study showed that 21.94 per cent of the issues presented can be categorized into class control. This finding shows that the chemistry student teachers considered class management as one of the issues to ensure effective teaching and learning. The following are examples of the proposed issues;

Classes today are not controlled. Many students spoke among themselves (Ibah)
Students are passive. (Azni)

Examples of reflective writing above showed that chemistry student teachers were dealing with the issue of inability to control the classes and students during teaching. Classroom management is one worrisome issue among trainee teachers (Balli, 2010). It is regarded as a never-ending issue for trainee teachers but it is not the main factor to reflect in the process of teaching and learning of science.

3.2.2. Time Management

In addition to the above, chemistry student teachers often bring up issues related to time management. 4 % of issues were written in this category. It is likely due to a lack of experience in conducting classes in the actual situation. Thus, chemistry student teachers are not able to divide time efficiently during class teaching activities. Here are some examples of reflection writing by chemistry student teachers;

Teachers cannot manage time well. (Uddin)
Need to predict the time for each objective. (Nora)

Reflections on time management is a good practice for chemistry student teachers to ensure that all the process of teaching and learning activities can take place on schedule. However, according to Nilsson (2008), effective teaching and learning should not focus on time factor only. Awareness on students' understanding of science concepts being taught should be more emphasized. Hence, high level of understanding will enable students to relate the concepts taught with the real phenomenon. Therefore, more teaching on certain concepts should be allocated if students require more time to understand them.

3. 2.3 Facilities

Four percent of the chemistry student teachers raised the issue related to how school facilities interfered with their teaching and learning process. Some examples of the issues raised are;

The projector does not work (Uddin)
Not enough chemical in the laboratory, the experiment cannot be done (Atie)

The above reflections clearly show that the chemistry student teachers were commenting on the effectiveness of the facilities either in the classroom or the school laboratory. This scenario indicates that existing facilities in schools also can become one of the factors which can disrupt the process of teaching and learning. According to Lee (2008) in his study involving trainee English teachers in Hong Kong, this issue is categorized as the first level of reflection within the reflection framework of Hatton and Smith (1995). The trainee teachers were only able to demonstrate the ability to look back at technical problems during the process of teaching and learning.

4. Conclusion

Overall the findings obtained in relation to the reflected issues by chemistry student teachers are as follow;

- There was a tendency to bring up issues based on pedagogical content knowledge in the implementation process of teaching and learning over general issues. Issues of pedagogical content knowledge being reflected were known as chemistry contents, importance of chemistry topic, students' difficulties, teaching strategies and assessment techniques. Meanwhile the general issues were related to class control, time management, facilities and cancellation of classes.
- The increase in the percentage of issues in Cycle II is a result of mentoring and guidance from lecturers and cooperative teachers based on pedagogical content knowledge of science.
- Reflections of issues displayed in Cycle II were more critical as compared to Cycle I . This scenario was due to the guidance of lecturers and cooperative teachers based on pedagogical knowledge of science content.

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