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Assessing In-service Teachers' Chemistry Content Knowledge and Self-efficacy in Teaching the K to 12 Science Curriculum

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ABSTRACT

As the K to 12 Science program was formally implemented, interventions to enhance competence and confidence of teachers in teaching science in a spiral progression approach are main concerns. This study aims to assess the chemistry content knowledge and self-efficacy of 38 in-service teachers enrolled in a graduate program from a teacher education institution using a content knowledge test (CKT) and a self-efficacy beliefs scale (SeS) using a mixed-method approach. Quantitative findings reveal that the least mastered topics in chemistry of the teacher-respondents include solutions, chemical bonding, the mole concept, gas laws, and chemical reactions. The science teachers say they are "somewhat confident" in teaching the chemistry topics. Qualitative findings include difficulties in answering the CKT and challenges encountered in teaching chemistry using the K to 12 science curriculum. In the needs analysis, key findings in the results of focus group discussion are used to verify quantitative findings. The correlation between content knowledge and self-efficacy beliefs is $r = -0.12$, with findings showing a negligible to low correlation. This implies that even if teachers perceive that they are "somewhat confident" in teaching chemistry topics, such beliefs do not match their content knowledge scores. Valid findings are based on the CKT results and further suggest that the CKT (not the SeS) is a good measure in determining the content learning needs of teachers.

Keywords: *content knowledge; self-efficacy; educational reform; teacher competence*

INTRODUCTION

Educational systems around the world aim to improve student achievement and skills to meet national and global standards. Implementation of educational reforms has been done by many in order to achieve this endeavor (Karam, 2015). In 2012, the Philippine basic education system formally implemented Republic Act No. 10533 known as the Enhanced Basic Education Act of 2013. The Act aims to strengthen the curriculum and increase the number of years for basic education in order to meet global standards and to equip graduates with necessary competencies, knowledge, and skills for lifelong learning and employment.

One of the salient features of the enhanced basic education curriculum is the use of the spiral progression approach. In the K to 12 science curriculum, concepts in biology, chemistry, physics, and earth sciences are

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presented in spiral progression where topics are taught with increasing levels of complexity from one grade level to another. Its purpose is to provide a deeper understanding of science core concepts and to ensure mastery of knowledge and skills. Science concepts and skills are organized into an interdisciplinary and multidisciplinary approach rather than discipline-based to emphasize the connections across science topics and other disciplines.

According to the Science Framework for Philippine Basic Education, a specific science discipline is being offered to a particular year level in the old science curriculum. Science content is presented in separate subjects and concepts are taught as isolated facts and principles (SEI-DOST & UP NISMED, 2011). In the new science framework, earth sciences, biology, chemistry, and physics are integrated in every grade level in a thematic manner. However, in the current curriculum of teacher training institutions, science teachers so far have been trained to major in a specific discipline. With the new science program, they will be required to teach other science disciplines (aside from their specialization), which necessitates mastery of several science areas.

Teachers are considered as the most important aid in the education process and as the key enabling factors in order to improve the quality of education (UNESCO, 2004). Thus, their knowledge of the content and their self-efficacy are needed for educational goals to succeed. According to McConnell et al. (2013), the foundation of effective teaching is the teachers' content knowledge. Having a substantive content knowledge serves as a prerequisite to teaching and integrating concepts into pedagogy (Santau et al., 2014). Teacher's self-efficacy is recognized as an essential factor that can lead to better student outcomes. It also contributes to effective teaching in many ways (Bray-Clark and Bates, 2003).

The success of educational change is dependent on the capacity of teachers to practice and deliver the prescribed expectations in the new science curriculum. Curriculum implementation encompasses several needs particularly in the development of teachers' content knowledge (Adams, 2000) and self-efficacy. Competence of teachers is a concern since human resource is considered as the most significant factor in ensuring better outcomes in the implementation of the new curriculum (Velasco, 2014). This study assesses the content knowledge and self-efficacy of in-service science teachers in chemistry. The adequacy of teachers' competencies, specifically their content knowledge and self-efficacy in teaching chemistry with the K to 12 science curriculum, are determined using the results reported in this study. Content learning needs are also determined through needs analysis to design appropriate professional development programs for in-service teachers. Chemistry topics are measured in this study to highlight the content learning needs of teachers, especially of the non-chemistry majors. There are few studies on chemistry content knowledge of teachers in the Philippine setting. This paper aims to contribute findings on the literature pertaining to the content knowledge and self-efficacy of teachers, specifically in teaching chemistry.

This study conforms to the principles of content knowledge and self-efficacy.

Content Knowledge. Shulman (1987) outlined four major sources of teaching knowledge. This study highlighted one source which is the scholarship in content disciplines. This refers to the knowledge, understanding, skill, and disposition that are meant to be learned by the students. In a classroom set-up, teachers serve as the "primary source" in understanding the subject matter. Teachers have the responsibility to demonstrate not only the depth and breadth of understanding of the subject matter but also the integration of content into different aspects. Content knowledge is considered as a central feature of teaching.

Self-efficacy. Albert Bandura (1997) described perceived self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments". Creating an environment conducive to learning depends heavily on teachers' self-efficacy. Teachers' perceived efficacy influences their general orientation in both educational processes and instructional activities. Self-efficacy lies at the heart of Bandura's social cognitive theory which explains motivation as both cognitive and behavioral (Elliott et al., 2000). It is a cognitive mechanism that serves as a guide to human actions and the perceived performance capabilities that influence a person's behavior. According to Bandura (1986), individuals gain information about their self-efficacy through various sources. It can be acquired through their performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. Performance accomplishments or actual performance attainment are the stronger factor that influences self-efficacy of individuals (Czerniak and Chiarelott, 1990). Through vicarious experience, individuals observe the performance of others. If others perform successfully or not in a given situation, individuals develop awareness on how to set expectations on their own performance. Social aspects such as verbal persuasion and physiological states such as emotional arousal also influence one's perceived self-efficacy. Learning also takes place through first-hand experiences (Bandura, 1986).

In this study, data about the content knowledge and self-efficacy beliefs of in-service science teachers were gathered. These data were used to determine content learning needs based on needs analysis. Specifically, this study attempts to answer the following research questions:

1. What is the content knowledge of in-service science teachers in chemistry according to the content knowledge test score?
2. What are the self-efficacy beliefs of in-service science teachers in teaching chemistry content included in the K to 12 science curriculum?
3. What is the correlation between content knowledge test scores and self-efficacy beliefs in teaching chemistry?

METHODOLOGY

This study utilized a mixed method approach. The quantitative approach of this study involved gathering and analyzing of data from content knowledge test scores and self-efficacy beliefs. On the other hand, the qualitative approach of this study involved results from focus group discussion (FGD). Triangulation design was used where quantitative and qualitative data were collected simultaneously and results were merged to compare and validate findings (Fraenkel and Wallen, 2003).

Respondents of the Study. This study used purposive sampling. Respondents were chosen since they are teaching the K to 12 science curriculum and they are also graduate students under a program for science education. The respondents of the study were science teachers enrolled in a graduate program from a teacher education institution in Manila. The science teachers are graduate students under the Master of Arts in Education major in Science Education program. One of the objectives of the said program is to prepare teachers to be well-rounded in teaching the four sciences to cope with the demands of the integrated spiral curriculum of the Department of Education. Data reported in this research came from 38 in-service science teachers. All the teacher-respondents are licensed professional teachers. They came from different schools in private and public education institutions. 34 respondents are graduates of Bachelor of Secondary Education with a specific area or field of specialization. 4 are non-education graduates, with two as graduates of Bachelor of Science in Nursing, one as a graduate of Bachelor of Science in Biology, and the other as a graduate of Bachelor of Science in Respiratory Therapy. They have acquired education units to be able to teach in high school. Figure 1 shows the profile of teacher-respondents according to field of specialization.

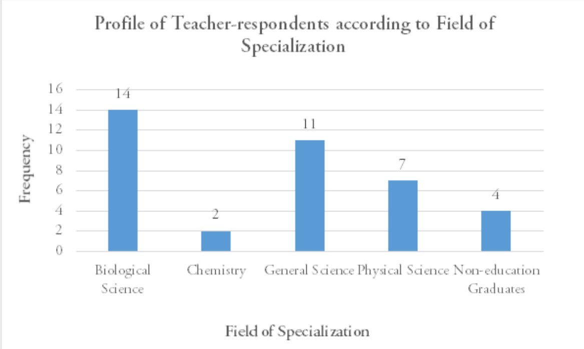

Figure 1. Profile of Teacher-respondents according to Field of Specialization.

The majority of the teacher-respondents are non-chemistry majors, thus their chemistry content knowledge is limited. However, this study focuses on chemistry because chemistry subjects such as inorganic, organic, and biochemistry are pre-requisite subjects in various fields of specialization for science majors. Moreover, since the K to 12 science curriculum is designed in a spiral progression approach wherein topics are revisited per grade level with increasing complexity, science teachers must be very familiar with all the concepts and the spiralling of the topics from the lower grade level up to high school. For instance, if a teacher is teaching in Grade Eight, it does not mean that he/she only focuses on and studies the topics included in the Grade Eight science curriculum. He/she must also be very familiar and knowledgeable with the topics in the previous grade level as well as with the next grade level since the topics are interconnected from one grade level to another.

Research Instruments. The content knowledge test (CKT) was used to measure content knowledge of teachers in chemistry. It includes some questions from 2003 and 2011 publicly released items of the Trends in International Mathematics and Science Study (TIMSS), high school chemistry textbooks, and researcher-made questions. The questions covered in the test are aligned with the Grades 7 to 10 chemistry content standards and learning competencies from the new K to 12 science curriculum. The test consisted of multiple choice and open-response questions. The test items were classified according to knowledge, comprehension, and application.

The self-efficacy beliefs scale (SeS) consisted of 14 items with eleven-point Likert scale asking the teachers to indicate how confident they are in teaching the chemistry content included in the K to 12 science curriculum. The scale was adapted and modified from Bandura's (2005) Guide for Constructing Self-efficacy. Teachers chose any number from 0 to 10, with 0 indicating "not confident" and 10 as "very confident."

The FGD questionnaire was used to obtain qualitative information to verify the responses of the teacher-respondents in the CKT and SeS. Results of the FGD were organized into key findings.

The CKT and the SeS were content-validated by chemistry content experts and piloted on 17 science teachers. The reliability of the scores on the CKT and the SeS were analyzed using Cronbach's α. The CKT scores had a Cronbach's α of 0.75 which indicated acceptable reliability. The Cronbach's α of SeS score was 0.97, indicating high reliability. The multiple-choice items were item-analyzed to ensure the validity and reliability of the research instrument.

A consent form was provided to the teachers. The objective of the research and confidentiality of their responses were explained prior to their participation. Teachers accomplished the educational and professional background form and the self-efficacy beliefs questionnaire. The CKT was administered without a time limit, and teacher-respondents answered the CKT based on stock knowledge. An FGD through structured interviews was conducted after the respondents answered the CKT and the SeS questionnaires to validate and verify their responses. This was also used to explore the qualitative findings to augment quantitative results. A copy of the interview questions was first provided to each respondent which served as a guide during the discussion. Respondents were asked to read the questions and then write their responses, and afterwards, an FGD was conducted. Responses were then classified according to the respondents' fields of specialization and key findings.

Needs Analysis. The needs analysis followed three stages: identification, analysis, and validation. In the identification stage, the percentage of correct answers per chemistry topic in the CKT was determined. The mean score across chemistry topics in the SeS was also determined. In the analysis stage, the relationship between the CKT score and the self-efficacy beliefs results was determined using the Pearson Product moment coefficient of correlation. This is to determine the congruency of the two data. Obtaining the correlation coefficient gave insight if content knowledge was a predictor of self-efficacy and vice versa. The result of the correlation determined the basis for identifying the content learning needs. In the validation stage, results from the analysis stage were verified with the key findings in the FGD.

RESULTS

Quantitative Data. Table 1 shows the descriptive statistics of the CKT scores. The Cronbach's alpha of the CKT results is 0.77 which indicates acceptable reliability.

Table 1. Content Knowledge Test Scores

FIELD OF SPECIALIZATION	*n*	**M*	*min*	*max*	*SD*
Biological Science	14	20.93	11	31	5.53
Chemistry	2	27.5	27	28	0.71
General Science	11	23	8	34	9.01
Physical Science	7	24.86	16	33	6.57
Non-education	4	18.25	8	28	8.18
OVERALL	*38*	*22.32*	*8*	*34*	*7.10*

**Highest Possible Score = 49 points*

The mean of the CKT scores was 22.32 out of a possible total of 49 points, with a standard deviation of 7.10. The overall mean score did not meet 50% of the highest possible score, which meant the test scores of the teacher-respondents were very low. Most of the open-response questions were unanswered even though the teacher-respondents had been given ample time to finish the test. The highest score in the test was 34 points coming from two General Science majors, while the lowest score was 8 out of 49 points coming from a General Science major and a non-education graduate (BS Respiratory Therapy graduate).

Figure 2 shows that the 2 Chemistry majors got the highest mean which was 27.5, followed by the 7 teacher-respondents who specialize in Physical Science, which was 24.86, then the 11 General Science majors with a mean of 23. The 14 Biological Science majors and 4 non-education graduates got a mean of 20.93 and 18.25, respectively.

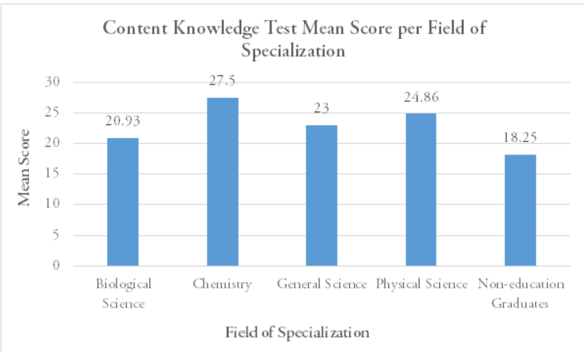

Figure 2. Content Knowledge Test Mean Score per Field of Specialization.

Table 2 shows the percentage of correct answers per topic by the teacher-respondents as revealed in the CKT. The chemistry topics were ranked from the least to highest percentage. The top 5 least mastered topics in chemistry by the teacher-respondents include solutions, the mole concept, chemical reactions, chemical bonding, and gas laws.

Table 2. Percentage of Correct Answers in Content Knowledge Test per Topic and Ranking of Least Mastered Topics in Chemistry

CONTENT	%	RANK
1) Solutions	19.67	1
2) Substances and Mixtures	65.67	12
3) Elements and Compounds	66.67	13
4) Acids and Bases	53	9
5) Metals and Non-metals	48.33	6
6) Particle Nature of Matter	49	7.5
7) Atomic Structure	63.33	11
8) Periodic Table of Elements	68.67	14
9) Chemical Bonding	44	4
10) Organic Compounds	49	7.5
11) Mole Concept	36.67	2
12) Gas Laws	44.33	5
13) Biomolecules	60	10
14) Chemical Reactions	40.67	3

The self-efficacy scores had a Cronbach's alpha value of 0.94 indicating high reliability. The overall mean score of the self-efficacy beliefs was 7.39 with a standard deviation of 1.28.

Table 3 shows the descriptive statistics of self-efficacy beliefs across the chemistry content. The data revealed that the teacher-respondents say that they were very confident in teaching the topic about elements and compounds while they were somewhat confident in teaching the rest of the chemistry topics.

Using Pearson's r, the correlation coefficient between the CKT scores and self-efficacy beliefs was -0.12 indicating that there was "negligible to low" correlation (Carroll and Carroll, 2003) between the two measures. This implied that even if the teacher felt that he/she was confident in teaching chemistry topics (as found in the self-efficacy beliefs), this did not guarantee that he/she possessed adequate content knowledge (as seen in CKT scores). Even if the teachers in general stated that they were "somewhat" or "very" confident in teaching chemistry topics, these perceived beliefs were not matched by their scores in the CKT.

The content learning needs of the teacher-respondents were based on the CKT only, which showed that they did not perform well, as reflected by their overall mean score. This was further intensified by the results of the FGD.

Qualitative Data. Analysis of FGD revealed two key findings. These include 1) difficulties in answering the CKT, and 2) challenges encountered in teaching chemistry using the new K to 12 science curriculum. The summary of the FGD with the teacher-respondents is as follows:

Table 3. Self-Efficacy Beliefs Per Content

CONTENT	*SD*	**M*	DESCRIPTION
1) Solutions	1.72	7.47	Somewhat Confident
2) Substances and Mixtures	1.64	7.61	Somewhat Confident
3) Elements and Compounds	1.54	8.29	Very Confident
4) Acids and Bases	1.41	7.55	Somewhat Confident
5) Metals and Non-metals	1.64	7.97	Somewhat Confident
6) Particle Nature of Matter	1.82	7.84	Somewhat Confident
7) Atomic Structure	2.05	7.68	Somewhat Confident
8) Periodic Table of Elements	1.67	7.76	Somewhat Confident
9) Chemical Bonding	1.90	7.39	Somewhat Confident
10) Organic Compounds	1.67	6.89	Somewhat Confident
11) Mole Concept	1.64	6.84	Somewhat Confident
12) Gas Laws	1.93	6.89	Somewhat Confident
13) Biomolecules	1.57	6.45	Somewhat Confident
14) Chemical Reactions	1.75	6.76	Somewhat Confident

**Interpretation Guide: 0-3.99 = Not Confident; 4.00-7.99 = Somewhat Confident; 8.00-10.00 = Very Confident*

Key Finding 1: Difficulties in answering the CKT:

BIOLOGICAL SCIENCE MAJORS. It was not difficult for the teachers to answer questions involving basic topics in chemistry and Grade 7 content. Those that were difficult for the teachers to answer came from Grade 10 content. These questions involved computations and topics such as chemical bonding and the mole concept. It was difficult for most teachers to answer Grade 10 content questions effectively because they had already forgotten the concepts and they had never experienced teaching those topics.

CHEMISTRY MAJORS: Questions which involved topics on atomic structure, organic chemistry, and matter were not difficult to answer.

GENERAL SCIENCE MAJORS: Basic chemistry concepts and Grade 7 content were not difficult to answer in the CKT. Questions on gas laws, atomic structure, Grade 9 and Grade 10 content were not difficult for 2 respondents. However, the rest mentioned that questions in Grades 8, 9, and 10 which include chemical bonding, chemical reaction, stoichiometry, and the mole concept were difficult to answer. Questions involving calculations were also difficult.

PHYSICAL SCIENCE MAJORS. The multiple-choice test was not difficult for three respondents, while the rest stated that atomic structure, balancing equations, periodic table of elements, and inorganic chemistry were also not difficult. However, respondents found the questions on the mole concept, percentage composition, and analysis difficult.

NON-EDUCATION MAJORS. The multiple-choice test was not difficult because respondents could “recall the answers.” Questions on solutions were also not difficult because they involved basic concepts in Chemistry. Questions which involved problem solving and chemical equations were difficult to answer.

In general, on the question about what topics the teachers need to learn/re-learn, the following topics were mentioned: biomolecules, organic compounds, gas laws, chemical bonding, chemical reactions, the mole concept, acids and bases, solutions, and atomic structure.

Key Finding 2: Challenges encountered in teaching Chemistry using the new K to 12 science curriculum

BIOLOGICAL SCIENCE MAJORS. It was difficult for the teachers to teach chemistry since they specialize in teaching biology. Limited teaching resources were also one of the challenges mentioned by the teacher-respondents.

CHEMISTRY MAJORS. Though they specialized in teaching chemistry topics, they also experienced difficulty because of the abrupt changes in the curriculum. For them, they had difficulty in teaching other sciences in the spiral approach.

GENERAL SCIENCE MAJORS. The scope of chemistry topics per grade level was one of the challenges mentioned by the General Science majors. The topics were still congested and the time allotment to teach some topics was lacking. Insufficient materials were also a problem.

PHYSICAL SCIENCE MAJORS. Retention of learning by students was a challenge mentioned by the respondents, who say that students are enrolled in the secondary level yet they have not mastered topics in the previous levels. Other challenges were the construction of the new science curriculum under the K to 12 program and the insufficient materials and learning resources available.

NON-EDUCATION MAJORS. Respondents experienced difficulty in teaching chemistry topics since they had less mastery of the content. They also had difficulty in the strategies to use in teaching chemistry.

To summarize, the challenges encountered in teaching chemistry using the new science curriculum include less mastery of the content, since teachers specialize in other science disciplines; teaching using the spiral progression approach; and insufficient teaching and learning materials.

DISCUSSION

The CKT is one measure used in this study to reveal the content knowledge of science teachers in chemistry topics covered in the K to 12 science curriculum. On average, only 46% of the questions were answered correctly by the teacher-respondents. This implies that the 38 teacher-respondents did not have complete mastery of the Grades 7 to 10 chemistry content, even though they had completed a degree with a field of specialization in science, passed the licensure examination for teachers, and enrolled in a master degree program in science education.

However, CKT scores might also be linked to respondents’ educational and professional background, such as their field of specialization, grade level taught, and teaching experience. These results were similar to the findings by Kind (2014) where teachers who were well qualified and academically able still held some significant misconceptions in basic chemistry concepts. Even teachers with chemistry background had insufficient mastery of the chemistry content (Coll and Taylor, 2001; Lucille, 2000; Lin et al., 2000).

Based on the FGD with the teacher-respondents, they stated that they had difficulty in answering application and comprehension questions most especially in the open-response type of test because they were not teaching those topics. Thus they had already forgotten the concepts. This suggests that teachers generally focus only on the topics they taught on the grade levels assigned to them.

With the spiral approach of the new science curriculum, it is important that teachers have breadth and depth of knowledge since topics from each grade levels are interconnected. According to the Framework for Philippine Science Teacher Education by SEI-DOST and UP NISMED (2011), if the science curriculum program requires students to master science concepts across disciplines, the teachers should also be required to do so. This requires teaching science in an integrated and spiral manner. Most of the questions in the CKT were adapted from the TIMSS. SEI-DOST and UP NISMED (2011) reported that students who got the highest scores in the said assessment fared better than the science teachers. Also, questions which involved computations were difficult for respondents to answer because some of them admitted that they were not really good in calculations. They had already forgotten the equations. They are not teaching those topics at all.

Moreover, there were constraints in the answering of the CKT. Though the teacher-respondents were given ample time to complete the questionnaires and answer the test, some teachers opted not to do so. There were incomplete and unanswered test papers most especially in the open-response type of questions. Teachers might have experienced fatigue while completing the questionnaires and answering the test which made them decide not to answer the questions. This might have led them to limit and shorten their responses. This is also a limitation reported in the study by McConnell et al. (2013). While teachers could have a deep and accurate knowledge and understanding of the concept, their test results might not totally reflect their content knowledge and understanding. During the FGD, there were two teachers who admitted that they were really in a hurry. Other respondents mentioned that they had already forgotten some chemistry topics since they had never experienced teaching them before. A chemistry major also explained that the problem-solving part of the test was tiring to do. These reasons were presumably why they were not able to answer the open-response questions.

The self-efficacy beliefs findings show that the teacher-respondents were somewhat confident in teaching all of the chemistry topics included in the new science curriculum except for the topic about elements and compounds. Factors such as educational and professional background could have led to these beliefs held by the teachers. However, possession of a good bachelor science education degree does not fully indicate having a good content knowledge (Kind, 2014). The findings in the CKT and the FGD contrasted with the findings in the self-efficacy beliefs. According to the needs analysis, as stated previously, the content knowledge test scores and self-efficacy beliefs have negligible to low correlation.

Thus, the CKT, together with the qualitative findings, but not perceived self-efficacy, could be used as bases for identifying the content learning needs of the teacher-respondents in teaching chemistry. According to McConnell et al. (2013), concept inventories which are similar to the construct of the SeS used in this study might lack the ability to reveal the precise information regarding the knowledge and understanding of the teachers. This suggests that providers of professional development programs should consider tools and strategies such as the CKT and FGD to identify specific and genuine content learning needs of teachers.

Qualitative data results have two implications. First, teacher-respondents experienced difficulty in answering questions in the CKT due to several reasons. One is they have insufficient knowledge of the chemistry concepts. Teacher-respondents' knowledge was limited to the grade level/s they were handling, which meant that teachers would tend to forget a topic in a particular subject matter if they had not been teaching it for a period of time. These findings are similar to Arzi and White (2007) where teachers tend to forget their unused content knowledge. Majority of the teacher-respondents also had difficulty in answering the open-response questions involving analysis and computations, implying that their math skills should also be enhanced.

Second, teacher-respondents encountered challenges in teaching the new K to 12 Science curriculum. They are still adapting to the changes in the curriculum such as the spiralling of the topics in science and the interdisciplinary approach. Teacher-respondents experienced difficulty in teaching chemistry especially if it was not their field of specialization. Hashweh (1987), Gess-Newsome and Lederman (1995), and Sanders et al. (1993) also state similar findings for teachers who taught topics outside of their specialization.

Another challenge is the congestion of topics in the different grade levels. Based on the FGD, there was lack of time in teaching a particular topic because the lessons were congested in the given quarter. Students' mastery and retention of the lessons were also one of the challenges encountered by the teacher-respondents. According to the results of the FGD, students were already enrolled in the secondary level even if they did not have a complete mastery of the science concepts in the preceding years. Insufficient teaching resources were also a challenge, particularly for respondents teaching in the public schools.

CONCLUSION

Quantitative and qualitative data revealed content learning needs of teacher-respondents in teaching chemistry. The CKT was able to identify the least-mastered topics, thus it correctly measured the content knowledge of the science teachers in chemistry. The SeS determined the confidence of the science teachers in teaching chemistry. However, results showed that even if teachers believe that they were somewhat confident in teaching chemistry content, their test scores were still below the passing rate. Thus, the CKT, not the SeS, is a better measure to determine the content learning needs of teachers since it reveals their depth and breadth of understanding.

However, the findings of this study were only based on 38 teacher-respondents. The relatively small sample size limits the generalizability of the findings. Increase in the sample size is recommended for further testing. The effects of professional trainings on teachers' content knowledge and measures of student achievement can also be done in future research.

This study suggests that even for teachers who have already completed a degree in teacher education with a particular field of specialization, and are academically able, they still need a continuous learning specifically on the content of the subject they are teaching. Changes in any educational system and curriculum are inevitable, therefore teachers must adapt to these changes, with as much support as the system can grant.

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