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Needs assessment of teachers' knowledge bases, pedagogical approaches and self-efficacy in implementing the K to 12 science and mathematics curriculum

Reston, Enriqueta D.
Science and Mathematics Education Department, University of San Carlos, Cebu City, Philippines (edreston@usc.edu.ph)
Cañizares, Monell John F. ✉
Science and Mathematics Education Department, University of San Carlos, Cebu City, Philippines (mjfcanizares@usc.edu.ph; monelljohnz@gmail.com)

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Abstract

This study aimed to assess the professional development needs of in-service science and mathematics teachers in order to provide baseline data for planning a continuing in-service professional development program to address teachers' needs in line with the implementation of the K to 12 science and mathematics curriculum. Teachers' professional development needs were assessed along with their teaching self-efficacy beliefs. The results showed that the teaching of Statistics, and Probability and Physics were the learning areas identified by majority of the math teachers (66.3%) and science teachers (57.7%), respectively, as the greatest area of need in terms of their pedagogical content knowledge for teaching. Teaching using the spiral progression approach, constructivist pedagogical approaches and assessment schemes were also the identified areas of development needs. The second phase consisted of workshop-based needs assessment among the teacher-respondents as a way of validating the identified areas of needs. While short-term workshops were the most preferred mode of professional development by both groups of teachers, they were divided almost evenly between choosing a long-term Master's degree and an intermediary Certificate Program for teaching in their field. Implications and recommendations for future directions in both curriculum and teachers' professional development are discussed.

Keywords: needs assessment; professional development; K to 12 science and mathematics curriculum; knowledge bases; self-efficacy belief

Needs assessment of teachers' knowledge bases, pedagogical approaches and self-efficacy in implementing the K to 12 science and mathematics curriculum

1. Introduction

The implementation of the *K to 12 Basic Education Program* in June 2012 is a major change in the educational landscape of the Philippines. The government rationalized this reform as an expansion and enhancement of the basic education curriculum to improve its quality and outcomes and to meet international accreditation standards (Department of Education, 2012). Moreover, since teachers play a significant role in the attainment of the national goals of quality basic education in any educational reform, in-service teacher professional development is an equally important concern.

In current practice, it has been observed that professional development efforts for teachers are primarily episodic and training oriented. The most popular approaches in practice are in the form of short-term seminar-workshops and mass trainings which are usually "one-size-fits-all" form of training. In most of these training programs, teachers are placed in passive roles as consumers of knowledge with little or no reflection on the connections to their own teaching practice. In developing countries and emerging economies like the Philippines, sustaining teachers' professional development through seminar-workshops requires much financial outlay yet their impact on teaching practice is not well established. Hawkes and Romiszowski (2001) contended that many educational reform efforts targeting improved student outcomes have been unable to produce the kind of desired learning outcomes and they attributed this failure to the lack of sustained, serious, systemic investments in the knowledge base of individual teachers. While providing extensive training to teachers regarding the new curriculum is a common implementation strategy for any curriculum reform, Sahlberg (2006) argued that it is not sufficient for successful change that typically involves people's awareness, knowledge, skills and beliefs. He further contends that curriculum change is a learning process for teachers and for better implementation of new curriculum into practice, it is necessary that they have a good understanding of the change and a clear conception of the new curriculum.

In line with the *K to 12* Basic Education reform, the challenge to improve and strengthen the teaching of science and mathematics is felt more than ever in the light of increasing recognition of the importance of these fields in the development of 21st century skills for students to cope with the demands of scientific and technological advances. This study is also a response to the community's increasing demands on institutional accountability in teacher preparation and sustained professional development. This paper reports the results of a needs assessment survey and workshop–based approach as a first step in designing a teacher development program that will be responsive to the needs of the community, particularly among schools and science/mathematics teachers in the basic education department.

Statement of the Problem - This study aimed to assess and evaluate the professional development needs of in-service science and mathematics teachers in Metro Cebu, Philippines in order to provide baseline data for planning a sustainable in-service professional development for science and mathematics teachers that address their professional knowledge bases, pedagogical skills and dispositions for implementing the reformed K *to 12* science and mathematics curriculum in basic education. In particular, this study sought to:

- Assess the professional knowledge bases of science and mathematics teachers as to the content knowledge and the pedagogical content knowledge (PCK)
- Assess teachers' self-efficacy in implementing the K to 12 Basic Education reform in line with the goals of science/mathematics teaching in terms of spiral progression and constructivist pedagogical approaches.

2. Review of Related Literature

With the implementation of the *K to 12 Basic Education* Program in the Philippines (Republic Act No. 10533), it is of vital concern to look into teachers' professional development needs as they cope with the demands of this reform. In particular, one great bearing in science and math teaching is the use of *spiral progression approach* and teaching pedagogies that are constructivist, inquiry-based, reflective, collaborative and integrative (Sec.5, R.A. 10533, 2013). These features have deep repercussions in terms of pre-service and in-service teachers' preparation, particularly in science and mathematics.

Further, Republic Act No.10533 stipulates the need for the Department of Education (DepEd) to collaborate with the Commission on Higher Education (CHED) on initiating professional development programs to ensure constant upgrading of teacher skills so that the enhanced basic education program meets the demand for quality teachers and school leaders. In particular, it is stipulated in Section 7 that in-service training on content and pedagogy will be provided by DepEd to teachers in order to meet the content and performance standards of the new *K to 12* curriculum.

The *K to 12* science curriculum (Department of Education, 2012) envisions "the development of scientifically, technologically, and environmentally literate and productive members of society who manifest skills as critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision makers, and effective communicators." (p.1). The conceptual framework for this curriculum identified three domains of learning science; namely: (1) *understanding and applying scientific knowledge* in local setting as well as global, context whenever possible, (2*) performing scientific processes and skills*, and (3) *developing and demonstrating scientific attitudes and values*. Further, DepEd (2012) recommended the following approaches for implementation of the science curriculum: multi/interdisciplinary approach, science–technology society approach, contextual learning, problem/issue-based learning, and inquiry-based approach. The approaches are based on sound educational pedagogy namely: constructivism, social cognition learning model, learning style theory, and Gestalt psychology.

On the other hand, the *K to 12* Curriculum Guide for Mathematics (DepEd, 2012) stipulates that "the twin goals of mathematics in the basic education levels are *critical thinking* and *problem solving*. Within the five content areas articulated in the mathematics curriculum guide; namely: *Probability and Statistics, Geometry, Patterns and Algebra, Measurement* and *Numbers and Number Sense, K to 12* mathematics teachers are then faced with the challenge of achieving these goals using mathematics content media and appropriate tools relevant to the contexts of Filipino learners. Further, the *K to 12* Mathematics curriculum frameworks is grounded by the following fundamental learning philosophies and models: Inquiry-based Learning, Experiential and Situated Learning, Cooperative Learning and Discovery, Reflective Learning and Constructivism. Thus, teachers are expected to achieve these goals of developing critical thinking and problem solving skills in their students using these pedagogical approaches. These features of the K to 12 basic education reform requires a broad base of knowledge for teachers not only of subject matter content but also of a range of pedagogical approaches for teaching the reformed science and mathematics curriculum.

2.1 Models of Teacher Development and the Role of Needs Assessment

Wei, Darling-Hammond, Andree, Richardson, and Orphanos (2009) assert that there is a need for a change in the way professional development is typically conceptualized as a quick effort or episodic set of activities. It must evolve into one that takes time for learning to occur through a systematic and coordinated set of activities in improving teacher knowledge given the opportunities to collaborate and reflect on their existing practices and to create the conditions for optimal learning.

In science and mathematics education, Loucks-Horsley, Hewson, Love and Stiles (2003) assert that professional development programs should pay explicit attention on the range of knowledge bases that teachers need for teaching, including teachers' content knowledge and beliefs about teaching and learning, as well as teachers' professional contexts. Mishra and Koehler (2006) also claim that for effective professional development experiences, there is a need to provide teachers the opportunities to build their content and pedagogical content knowledge and skills and to examine their practices critically. These more recent versions of professional development emphasize critical reflection on teaching practice through collaboration and collegial dialogue.

Another model of professional development emphasizes the importance of needs assessment as a starting point in planning for professional development (Arome & Levine, 2007). While this professional development model features the integration of reflective practice and inquiry, the proponents assert that special considerations for the professional development plan must begin with a *needs assessment* of the faculty and the students which includes surveys conducted to identify the teaching strategies, teaching resources, technologies, and support being currently used.

2.2 Science and Mathematics Teachers' Self Efficacy

Teachers' self-efficacy is another construct considered in the assessment of teachers' professional development needs. Tschannen-Moran, Woolfolk, Hoy and Hoy (1998, cited in Swackhamer, Koellner, Basile, & Kimbrough, 2009) argued that a teacher's sense of self-efficacy has been consistently recognized as an important attribute of effective teaching and has been positively correlated to teacher and student outcomes. Teachers' self-efficacy is defined as the beliefs of teachers related to their capabilities to affect the learning outcomes of students including those with low motivation and low ability to learn (Bandura, 1995; cited in Ozder, 2011).

Swackhamer et al. (2009) described a five-year project in the United States designed to explore the impact of content courses that also emphasize pedagogy on the self-efficacy levels of in-service middle school teachers with lower levels of content knowledge in math or science in seven Denver-area school districts. The results revealed that in-service teachers' outcome efficacy was higher in teachers who have taken four or more math or science content courses. Their study made an important contribution to the field of self-efficacy research due to the implication that changes can be made to outcome efficacy in experienced teachers through professional development or content-based mathematics or science course work that draws out the teachers' intrinsic values and interests.

From the foregoing literature review, teacher's various forms of knowledge bases for teaching, along with their pedagogical practices and self-efficacy beliefs were explored as basis for identifying professional development needs that may be derived from the data.

3. Research Method

This study used cross-sectional descriptive survey design to assess the professional development needs of teachers. The target population comprises the junior high school science and mathematics teachers in both private and public schools of Metro Cebu, Philippines comprising the cities of Cebu, Mandaue, Lapu-lapu, Talisay and the municipalities of Consolacion and Minglanilla. A list of private and public schools of Metro Cebu obtained from the Department of Education Regional 7 Office served as the sampling frame of the study. Multistage sampling comprising of stratified sampling (private and public schools) and area cluster sampling by schools were used to select the respondents as representative of these cities. A total of 111 science and 92 math teachers from 8 public and 9 private schools responded to the survey. Institutional approval from the Department of Education and the participating schools and informed consent of participants were obtained before the conduct of the needs assessment. Table 1 provides a summary of the distribution of respondents in the study.

Table 1

Distribution of Teacher-Respondents by Type of School and Subject Taught

Type of School	Math		Science	
	n	%	*n*	%
Private (*n* = 9)	22	23.91	27	24.32
Public (*n*= 8)	70	76.09	84	75.68
Total	92	100.00	111	100.00

As shown, majority of the Math and Science teacher-respondents (76.09% and 75.68%, respectively) came from the public schools. There were more Math and Science teachers from public schools due to the densely populated public school system where education is for free, and thus, requires a good number of teachers.

During the first phase of data collection, the needs assessment questionnaires were distributed to the science and mathematics teachers from the randomly selected schools through the school principals and science/math coordinators. The research instrument consists of a parallel form needs assessment questionnaires for science and mathematics teachers. They were researcher-made and comprise several components; namely: (1) Personal, Educational and Professional Profile; (2) Teacher's Self-Assessment of their content knowledge (CK), pedagogical content knowledge (PCK) and technological, pedagogical and content knowledge (TPACK) in a 7-point Likert scale, (3) Teacher's Assessment of their Teaching Practice, and (4) Teacher's Assessment of their Self-Efficacy beliefs. The items for CK in part (2) of the questionnaire were based in the learning domains of the science/mathematics K to 12 curriculum while the PCK and TPACK items were based on the pedagogical approaches and modes of technology integration specified in the curriculum. Part (3) of the questionnaire consisted of a range of teaching practices from behaviorist to constructivist practices extracted from the work of Prince and Felder (2006) where the teachers' reflect on their own practices in comparison with the items on a scale indicating frequency of practice from 1 (seldom) to 4 (almost always). Part 4 of the questionnaire is a self-efficacy scale based on an adaptation of the Science Teaching Efficacy Belief Instrument (STEBI-B) developed by Riggs and Enoch (1990) with some modifications for the mathematics items.

The questionnaires were pilot tested using a sample of secondary school science and mathematics teachers from the Basic Education Department of a large private university. Results of the pilot test were subjected to reliability analysis using the Statistical Package for the Social Sciences (SPSS) version 20. The results showed that the reliability for the Teaching Practice scale yielded Cronbach alpha values of 0.793 and 0.882, for science and mathematics, respectively, as measures of internal consistency of the scale. For the Self-Efficacy scale of the questionnaire, the reliability analysis yielded Cronbach alpha values of 0.640 and 0.770 for science and mathematics, respectively.

For the treatment of data, descriptive statistics using numerical summary measures and frequency and percentage distribution tables were used to organize quantitative data from the survey. From among the respondents of the survey, a workshop-based needs assessment was conducted to verify and document various forms of teacher knowledge and pedagogical skills that might be needed by the teachers. The second phase consisted of the design of activities and gathering data from workshop sessions organized for volunteer science/mathematics teachers who participated in the survey. The one-day workshop was conducted with pre-and post-assessments on teachers' knowledge bases and pedagogical skills as bases for identification of needs. The identified constructivist pedagogical approaches of *K to 12* were applied in these science/math content-based workshops. Teachers' worksheets and work samples also formed another source of data from working groups during workshops on their knowledge bases and pedagogical skills. The workshop has separate sessions for science and mathematics teachers.

4. Results and Discussion

This section presents the results of the needs assessment for both mathematics and science teachers. Since the nature of needs for mathematics and science teachers may vary, the presentation of results and discussion for these two groups of teachers are made in separate subsections. Further a preliminary characterization of the teachers' educational and professional preparations is presented prior to the results of pre-assessing their knowledge bases to provide a better understanding of the teachers and their needs.

4.1 Educational and Professional Preparations of Mathematics and Science Teachers

Educational Qualifications - The ideal pre-service teacher preparation for teaching secondary mathematics is BSEd–Math and most teachers (85.87%) have this degree as shown in Table 2. On the other hand, non-BSEd holders must take a Diploma or Certificate program in professional education to qualify them to take the licensure examination and teach in Basic Education (9.78%). In terms of advanced degrees, the results for mathematics teachers revealed that only 28.57% of the respondents earned a master's degree; however, only 9.79 or roughly 10% of them earned a master's degree in teaching mathematics. Most of these math teachers who earned a Master's degree in Education specialized either in Educational Administration or in Guidance Counseling, and thus, not directly relevant to the field where they teach. In terms of doctoral degree, only 4 math teachers have a PhD but none of them has a specialization in mathematics teaching.

Table 2

Educational Qualifications of Mathematics Teachers by Degree Earned

Degrees Earned		*n*	%
Bachelor's Degree			
BSEd major in Mathematics		79	85.87
BSEd (major in Physics –Math, Biology/ General Science)		4	4.35
BS Mathematics		4	4.35
		5	5.43
	Total	92	100
Master's Degree			
MA in Teaching Math		7	7.62
MS in Teaching Math		2	2.17
MA in Education (major in School Administration, Guidance and Counseling)		12	13.04
	Total	28	28.57
Doctoral Degree			
PhD in Education (major in Educational Administration, Management, Research &Evaluation)		3	3.26
PhD in Public Administration		1	1.09
	Total	4	4.35

In terms of educational preparation, there is indeed a great need to strengthen content expertise of mathematics teachers through the pursuit of graduate degree programs which specialize in mathematics and its related area. The results show a very minimal percentage of teachers with master's degree in teaching mathematics and none have pursued a doctoral program in mathematics education.

On the other hand, for science teachers, the results in Table 3 revealed that of 111 teachers, 67 (60.37%) earned a teaching degree related to the sciences where most of them earned the degree BSEd in General Sciences (58.20%). Moreover, 11 teachers (9.90%) had undergraduate degrees not related to Science Teaching that includes engineering, medical technology, agriculture, commerce and industrial education. The data reflects the diversity of science teachers' educational preparation and thus, the need to focus their professional development on content expertise in the areas of science where they currently teach.

In terms of the science teachers' pursuit of advanced degrees through graduate studies, the results shown in Table 4 also confirm the need for further specialization in the science areas where they teach. Only 18 out of 111 respondents (16.21%) finished their master's degree in Science Education related to their field either in General Science, Chemistry, Physics and Biology with most of them in General Science. With the implementation of the spiral progression approach, these Science teachers are expected to be knowledgeable in all fields of science: earth science, biology, chemistry and physics. However, 12 (10.80%) of respondents have Master's degree in

Education that do not relate directly to science teaching in high school but have something to do with administrative supervision, special education and instructional technology development. Further, there are two respondents who finished their Doctoral Degree; one is a Doctor of Education graduate while the other was as Doctor of Philosophy graduate majoring in Educational Management. This further reflects the need for teachers to developing content expertise in their areas of specialization in science.

Table 3

Distribution of Science Teachers' by Bachelor's Degree Earned

Bachelor's Degree Earned	*n*	%	Aggregate Percentage
In-line Teaching Degrees			
BSEd General Sciences	39	35.14	60.37
BSEd Physical Sciences	9	8.11	
BSEd Biological Sciences	7	6.31	
BSEd Physics and Math	7	6.31	
BSEd Physics and Chemistry	5	4.50	
Other Teaching Degree			
BSEd Math	1	0.90	0.90
Related Pure Science and Math Degrees			
BS Biology	14	12.61	18.91
BS Physics	5	4.50	
BS Chemistry	1	0.90	
BS Math	1	0.90	
Other Degrees			
BS Chemical/Computer Engineering	5	4.50	9.90
BS Nursing/Medical Technology	3	2.70	
BS Commerce	1	0.90	
BS Agriculture/ Industrial Education	2	1.80	

Table 4

Distribution of Science Teachers by Graduate Degrees Earned

Master's Degree Earned	*n*	%	Aggregate Percentage
In-line Master in Science Education Degree			
MAEd General Science	11	9.91	16.21
MAEd Chemistry	3	2.70	
MAEd Physics	3	2.70	
MAEd Biology	1	0.90	
Other Master in Education Degree			
MAEd Math	2	1.80	1.80
Unrelated Master in Education Degree			
MAEd Administrative Supervision	7	6.31	10.81
MAEd Special Education	3	2.70	
MA Instructional Development and Technology	2	1.80	
Other unrelated Master's Degree			
MA Human Resource	1	0.90	1.80
Master in Nursing	1	0.90	
Total	34	30.61	30.61
Doctoral Degree Earned			
Doctor of Education	1	0.90	1.80
PhD Educational Management	1	0.90	
Total	2	1.80	1.80

Certificate Programs - For certificate programs completed, the results shown in Table 5 indicate that almost half of the math teachers completed a certificate program in Professional Education but only one completed a certificate program with a specialization in Mathematics.

Table 5

Certificate Programs Completed by Mathematics Teachers

Certificate Programs Completed		*n*	%
Certificate in Professional Education		44	47.83
Certificate Program in Mathematics		1	1.09
TESDA National Certification (NC II & III)		2	2.17
Understanding and using effective cooperative learning, models for secondary mathematics, SEAMEO-RECSAM		1	1.09
	Total	48	52.17

For science teachers, Table 6 shows that 63 (56.75%) of the respondents completed various types of certificate courses as a continuing professional education and a testimony of being a lifelong learners. Moreover, only six teachers finished certificate programs that specialized in Science Teaching that directly relates to their field of teaching. Most of the respondents finished a Certificate in Professional Education which may be understood in terms of the data in Table 3 where only 61.27% were actually BSEd graduates eligible to apply and take the Licensure Exam for teachers (1 teacher is BSEd Math graduate). Teachers who were non-BSEd graduates had to complete at least 18 units of Professional Education subjects to qualify them for the Licensure Examination for Teachers (LET). On the other hand, some 4.5% of the science teachers completed certificate programs not related to their field.

Table 6

Certificate Programs Completed by Science Teachers

Certificate Programs Completed	*n*	%	Aggregate Percentage
In-line Science Teaching Certificate Courses			
Certificate in Science Teaching Biology	3	2.70	5.40
Certificate in Science Teaching Physics	2	1.80	
Certificate in Science Teaching Chemistry	1	0.90	
In-line Education Certificate Courses			
Certificate in Professional Education	52	46.85	46.85
Other unrelated Certificate Courses			
Certificate in Special Education	2	1.80	4.50
Certificate in Sign Language	1	0.90	
TESDA National Certification	1	0.90	
CISCO Computer training	1	0.90	
Total	63	56.75	56.75

***Teaching Experience* -** In terms of the teacher's professional experience, the results in Tables 7 and 8 showed that in the school they are currently employed were 5 years or less (50.6% mathematics teachers and 41.4% science teachers). About half of both math and science teachers have prior teaching experience in other schools. Furthermore, more than half of the teachers teaching in their current school have less than 10 years teaching experience.

Table 7

Current and Previous School Teaching Experience of the Math Teachers

Teaching Experience, in years	Current School Employed		Previous School Employed	
	n	%	*n*	%
1 to 5	45	50.6	33	37.1
6 to 10	14	15.7	12	13.5
11 to 15	8	9.0	1	1.1
16 to 20	8	9.0	1	1.1
More than 20	14	15.7	0	0.0

Table 8

Current and Previous School Teaching Experience of the Science Teachers

Teaching Experience, in years	Current School Employed		Previous School Employed	
	n	%	*n*	%
1 to 5	46	41.4	43	38.70
6 to 10	25	22.5	17	15.30
11 to 15	10	9.00	3	2.70
16 to 20	10	9.00	3	2.70
More than 20	11	9.90	0	0

For both math and science teachers, the trend is similar with a little over one-third of them having taught previously in another school and there is a decreasing percentage as the number of years increases with none (0%) having previously taught for more than 20 years in another school. This trend indicates that teachers' decision to transfer to another school is usually done within their first five years of teaching and they tend to settle down with their employment in the school they currently teach over the years teaching.

In-service Professional Trainings Attended - In-service teacher development is an integral part of teaching preparation particularly in light of the on-going K to 12 Basic Education reform. For the mathematics teachers, the results in Table 9 indicate that it is the training on Assessment (particularly on the KPUP framework, to note that the Department of Education had currently ordered DO No.8, s.2015 on the new assessment scheme-WW-PT-QA framework which was implemented on all public schools effective school year 2015-2016) which was attended most by the teachers (42.40%) and only 37.00% of them attended professional trainings in math content specialization. Most of the math teachers attended only these trainings once with a modal duration of 5 days. These training programs could be attributed to the five-day mass training for in-service teachers in line with the implementation of the K to 12 basic education curriculum.

Table 9

Professional Trainings Attended by Mathematics Teachers

Professional Trainings Attended	*n*	%	Modal Frequency	Modal Duration (days)
Assessment/ KPUP	39	42.40	once	5
Math Content Specialization	34	37.00	once	5
Teaching Strategies	21	22.8	once	1
Spiral Progression	16	17.4	once	5
ICT/ Educational Technology	17	18.5	once	1

For the science teachers, as shown in Table 10, trainings in science content specialization had the highest percentage of teachers in attendance (44.10%), followed by trainings on Spiral Progression (33.3%) and Assessment/KPUP (32.40%), respectively. The results also indicate that most of these teachers attended these trainings only once and with duration of 5 days.

Table 10

Professional Trainings Attended by Science Teachers

Professional Trainings Attended	*n*	%	Modal Frequency	Modal Duration (days)
Science Content Specialization	49	44.10	once	5
Spiral Progression	37	33.30	once	5
Assessment/ KPUP	36	32.40	once	5
Teaching Strategies	32	28.80	once	1
ICT/ Educational Technology	20	18.00	once	1

These findings for both Tables 9 and 10 indicate that for both mathematics and science teachers, while some teachers were privileged to have attended these very important professional trainings in response to DepEd's implementation of the *K to 12* basic education curriculum, the impact of these trainings may be minimal as less than 50% of the respondents have attended these in-service trainings. This means that majority of the teachers have not been sent yet to these training programs and thus, require further updating to prepare themselves for the *K to 12* curriculum initiatives. The trend though is different for math and science teachers. While science content specialization and spiral progression where the most attended trainings for science teachers, it is the trainings on Assessment/KPUP followed by math content specialization that were most attended by the math teachers. Further, trainings on teaching strategies and ICT have been given minimal emphasis in terms of training duration (1 day only) and lesser percentage of teachers in attendance.

4.2 Identified Areas of Need for Professional Development

These areas of need where categorized into three; namely: (1) content knowledge, (2) pedagogical approaches, and (3) assessment. For the mathematics teachers, the results in Table 11 reveal that of the five content areas or learning domains in the *K to 12* math curriculum, it is Probability and Statistics which was identified by majority of the math teachers (66.30 %) as the content areas that needs further development. This is followed by Geometry, with 29.30% of the math teachers, while the area on Measurement was identified by the least number of teachers as an area of development need in terms of content.

For pedagogical approaches, approaches for *integrating technology in teaching* was identified by most math teachers (40.20%) as their need for capacity development, followed closely by approaches in *teaching for critical thinking* (39.10%). Critical thinking has been identified as one of the twin goals for teaching mathematics in the *K to 12* curriculums, along with problem-solving. While problem-solving activities have been an integral part of many math classrooms and math teachers may have a rapporteur of teaching strategies for this, math teachers may still need to develop further their skills in designing activities for developing critical thinking.

Table 11

Math Teachers' Identified Areas of Need for Professional Development

Areas of Need	*n*	%
Math Content Knowledge		
Probability and Statistics	61	66.30
Geometry	27	29.30
Algebra and Pattern	10	10.90
Number Sense	9	9.80
Measurement	5	5.40
Pedagogical Approaches		
Integrating Technology	37	40.20
Teaching for Critical Thinking	36	39.10
Spiral Progression	22	23.90
Constructivist Teaching	17	18.50
Inquiry-based Teaching	10	10.90
Assessment		
KPUP Assessment	45	48.90
Rubric Construction	28	30.40
Formative Assessment	12	13.00
Test Construction	11	12.00

For Science teachers, the identified areas of need for professional development are summarized in Table 12. For Science content knowledge, 64 (57.70%) teachers wanted to have training seminar focusing on Physics concepts, 37 (33.30%) teachers both wanted seminar training on Chemistry and Biology while content specialization on Earth Science is at the last with 19 (17.10%) teachers signifying the need. Constructivist teaching with 56 respondents (50.50%) is at the top of the list in terms of pedagogical content knowledge needs, followed by spiral progression with 44 (39.60%) teachers. Integrating technology was identified by 28 (25.20%) teacher respondents needing the training interventions and inquiry-based teaching has 26 (23.40%) teachers agreeing for the training needs. Significantly, teaching for critical thinking is at the bottom list priority of teachers (*n*=21, 18.90%). Though, constructivist teaching would encompass all other pedagogical content knowledge as it served as the umbrella framework for the *K to 12* curriculum, it is of equal importance for science teachers to develop teaching for critical thinking to their students given the investigative nature of science. On the other hand, KPUP (Knowledge, Process, Understanding and Product) assessment registered the highest respondents with 64 (57.70%) signifying the need. Rubric construction, formative assessment and test construction followed, respectively (*n*=33, 29.70%, *n*=30, 27.0%, and *n*=25, 22.50%). It is important to note that while KPUP assessment is at the top of the priority list of teachers when this research was conducted, DepEd (2015) written works (ww), performance task (pt) and quarterly assessment (qa).

Table 12

Identified Areas of Need for Professional Development for Science Teachers

Science Content Knowledge	*n*	%
Physics	64	57.70
Chemistry	37	33.30
Biology	37	33.30
Earth Science	19	17.10
Pedagogical Content Knowledge		
Constructivist Teaching	56	50.50
Spiral Progression	44	39.60
Integrating Technology	28	25.20
Inquiry-based Teaching	26	23.40
Teaching for Critical Thinking	21	18.90
Assessment		
KPUP Assessment	64	57.70
Rubric Construction	33	29.70
Formative Assessment	30	27.00
Test Construction	25	22.50

When asked about their preferred mode of professional development, the results in Table 13 showed slight differences in the distribution of teachers' preferences. While a short-term 1 to 2 week-workshop was the dominant preferred mode for the mathematics teachers, the science teachers preferred Certificate Program for teaching in in their field. Both groups of teachers considered participation in professional developments using reflective practice models of professional development such as action research, lesson study or building a community of practice as least preferred mode.

Table 13

Teachers' Preferred Mode of Professional Development

Professional Development Modes	Math Teachers		Science Teachers	
	n	%	*n*	%
1 to 2 –Week Workshop	37	40.20	42	37.80
24-unit Certificate Program in Teaching Mathematics/Science	22	23.90	45	40.50
36-unit Master's Program in Teaching Mathematics/Science	23	25.00	23	20.70
Action Research/Lesson Study/ Reflective Community of Practice (CoP) Approaches	18	19.60	13	11.70

4.3 Mathematics Teachers' Self-Efficacy

One important construct to consider in the needs assessment of the teachers is their self-efficacy beliefs. Tschannen-Moran et al. (1998, cited in Swackhamer et al., 2009) claimed that effective teaching is attributable to the teacher's sense of self-efficacy which in turn correlates to the teacher and student outcomes.

The instrument used to measure math teachers' self-efficacy was based on the Science Teaching Efficacy

Belief Instrument (STEBI-B) developed by Riggs and Enochs (1990) and anchored on Bandura's Self-Efficacy Theory which comprised two dimensions; namely: (1) Personal teaching efficacy and (2) Teaching outcome efficacy. Personal teaching efficacy (PTE) refers to the teacher's belief in his or her skills and abilities to positively impact student achievement while teaching outcome efficacy (TOE) is defined as the teacher's belief that the educational system can work for all students (Riggs & Enochs, 1990).

Following the work of Swackhamer et al. (2009) in which the STEBI-B instrument was administered to both science and mathematics teachers with minor modifications on the items and subsequent validation, this study also used the instrument to include math as well as science teachers with two additional items on teachers' self-efficacy to implement a spiral progression approach in their subjects. Thus, the scale used in this study has 25 items in contrast with the original STEBI-B with 23 items.

A reliability analysis was performed on the modified 25-item scale for Math teachers using the Statistical Package for the Social Science (SPSS) Version 20 and the results yielded a Cronbach alpha coefficient of *0.770* based on standardized items, which is a generally acceptable measure of reliability for the modified instrument. Table 8 shows the results of confirmatory factor analysis, using Principal Axis Factoring with Varimax rotation, as the means for construct validation of the modified scale relative to the original two-factor STEBI-B.

Table 14

Construct Validation of the Mathematics Teachers' Self-Efficacy Scale

Item #	Item idea	Factor		Communality
		1(PTE)	2(OTE)	
19	Helping students with difficulty in understanding a concept	.706	.119	0.656
18	Effectiveness in teaching and its influence on student with low motivation	.632	.031	0.581
23	Organization topics from simple to complex	.565	.376	0.733
3	Teaching math well	.539	.016	0.429
21	Broad knowledge for implementing spiral progression	.512	.271	0.608
15	Explain to students well how solutions to math problems are obtained	-.510	.022	0.42
6	Effective in monitoring math assessment	.478	-.159	0.371
17	Having the necessary skills to teach math	.427	.034	0.438
14	Students' achievement is directly related to their teachers' effectiveness	.162	.630	0.615
4	Student grade improvement due to effective teaching approach	.192	.590	0.574
13	Teacher as responsible for student achievement in math	-.038	.581	0.479
9	Overcoming students' inadequacy by good teaching	.051	.569	0.504
5	Knowing the strategies in teaching math concepts	.288	.468	0.443
11	Low achieving students progress due to extra attention	-.226	.459	0.493
8	Generally teach math effectively	.360	.452	0.482
2	Continually finding better ways to teach math better	.296	.436	0.470

The results in Table 14 show how the items in the modified STEBI-B are classified according to the two dimensions (factors) of teachers' self-efficacy. Of the 25 items, 8 items loaded highly on Factor 1 (Personal Teaching Efficacy) while another group of 8 items loaded highly on Factor 2 (Teaching Outcome Efficacy). Relatively high and significant factors were identified as those with loadings greater than or equal to 0.40 following the rule of thumb by Hair, Black, Babin, and Anderson (2013). The other nine items either cross-loaded (4 items) or did not significantly load with any of the two constructs (5 items). The distribution of mathematics teachers in terms of their level of self-efficacy for implementing the K to 12 mathematics curriculum is summarized in Table 9.

Table 15

Distribution of Math Teachers' to their Levels of Self-Efficacy in the K to 12 Mathematics Curriculum

Levels		Teachers' Self-Efficacy Dimensions			
		Personal Teaching Efficacy		Teaching Outcome Efficacy	
		n	%	*n*	%
Low		12	13.00	12	13.00
Moderate		60	65.20	67	72.80
High		20	21.70	13	14.10
	Total	92	100.00	92	100.00

Descriptive statistics results of math teachers' responses as shown in Table 15 indicate that majority of these teachers have moderate personal teaching efficacy (PTE) and teaching outcome efficacy (TOE). Moreover, there are more teachers with high level of PTE compared to TOE.

4.4 Science Teachers' Self-Efficacy

This section assessed the self-efficacy of science teachers in teaching their subjects to their students. The Self-Efficacy Belief Scale for science teachers consisted of 25 items divided into two subscales; namely: Personal Teaching Efficacy (PTE) and Teaching Outcome Efficacy (TOE). PTE, according to Swackhamer et al. (2009), is the belief of teacher's capacities to impact positive learning outcomes of the students while TOE is the teacher's belief that science education can work for students without accounting the socio-economic and parental influences. Using a Likert scale of extent of agreement from 1 (Strongly Agree) to 5 (Strongly Disagree), Table 16 presents the means and standard deviations of the responses for PTE with the minimum (lowest) and maximum (highest) possible ratings provided by the teachers for each items. Furthermore, reversed scoring for the six items were included in this table. The overall mean under this scale is 2.16 with a standard deviation SD = ±0.779. Taking into account what Palmer (2006; cited in Swackhamer et al., 2009) suggested of having a score of 3.0 to be neutral and having one standard deviation above and below this mark will indicate high and low level of efficacy. Thus, with PTE standard deviation of ±0.779, the threshold for high level efficacy would be 2.221 down. This threshold was met by the responding teachers particularly in the item on "welcoming students' questions" which is on top of the list in terms PTE of teachers with a mean value of 1.51. More importantly, the second item in rank "continually finding better ways to teach" follows closely with a mean value of 1.52 yet its minimum rating is 1 and maximum rating is 2 indicating a more homogeneous and consistent teacher responses. Items in which teachers indicate high levels of self-efficacy includes "I wonder if I have the skill to teach science (M=2.29)", "Find it difficult to explain to students (M=2.36)", "Not effective in monitoring science assessment (M=2.38)", "When student has difficulty, I am at a loss how to help them (M=2.69)" and "Effectiveness in teaching has little influence on student with low motivation (M=2.73)" which are all reverse coded items.

Following what Palmer (2006, mentioned in Swackhamer et al., 2009) had done in analyzing the Likert Scale used in this survey, and with the overall standard deviation of ±0.890, taking the score of 3 to be neutral, the threshold for high level of efficacy of TOE is 2.11 down. With the average of all the mean scores for all the items to be 2.39, the teaching outcome efficacy of the teacher respondents did not meet this threshold. It follows that in this category, the self-efficacy of the teachers, falls on the neutral bracket. In particular, the items "Student underachieve because of ineffective teaching" and "Increased effort in science teaching produce little change in achievement", ranked as the lowest in terms of science teaching outcome efficacy. The former is coded in reverse for easy analysis and to be used in computation to arrive at a view of its bigger picture. Despite of this, two items stand out to be at the high level of efficacy among teachers under TOE, that includes "Low achievement of students cannot generally be blamed to the teacher (M=1.81)" and "Inadequacy of students can be overcome by good teaching (M=1.85)".

Table 16

Descriptive Statistics for Science Teachers Responses to Personal Teaching Self-efficacy

Items	*n*	*Min*	*Max*	*Mean*	*SD*
I usually welcome students questions	109	1	4	1.51	.603
Continually finding better ways to teach	111	1	2	1.52	.502
Typically able to answer students' questions	111	1	4	2.02	.660
Generally teach science effectively	106	1	4	2.08	.500
I can organize topics from simple to complex	110	1	4	2.09	.583
I can identify the pre-requisite knowledge needed for the lesson	110	1	5	2.13	.679
Know the steps in teaching science concepts	109	1	5	2.21	.668
R - I feel I don't teach science well	110	1	5	2.06	.989
R - I wonder if I have the skill to teach science	109	1	5	2.29	.864
R - Find it difficult to explain to students	110	1	5	2.36	.974
R - Not effective in monitoring science assessment	110	1	5	2.38	.938
R - When student has difficulty, I am at a loss how to help them	108	1	5	2.69	1.054
R - Effectiveness in teaching has little influence on student with low motivation	110	1	5	2.73	1.108
Ave. of Means and SD				2.16	.779

Table 17

Descriptive Statistics for Science Teachers Responses to Science Teaching Outcome Efficacy

Items	*n*	*Min*	*Max*	*Mean*	*SD*
Low achievement of students cannot generally be blamed to the teacher	111	1	4	1.81	.815
Inadequacy of students can be overcome by good teaching	110	1	4	1.85	.719
I can teach to develop students' scientific attitudes and values	110	1	4	2.03	.550
I can teach to develop students' scientific inquiry skills	110	1	4	2.08	.692
When low student progress it's because of my extra attention	111	1	5	2.17	.862
Student grade improved because of my effective teaching approach	110	1	4	2.22	.783
Students do better because I exerted extra effort	110	1	5	2.23	.831
Students' achievement is directly related to their teachers' effectiveness	109	1	5	2.37	.930
Teacher is generally responsible for student achievement in science	110	1	5	2.58	1.053
I have a broad knowledge to implement spiral progression	109	1	5	2.72	.881
Student underachieve because of ineffective teaching	108	1	5	3.12	1.158
R - Effectiveness in teaching has little influence on student with low motivation	110	1	5	2.73	1.108
R - Increased effort in science teaching produce little change in achievement	109	1	5	3.12	1.192
Ave. of Means and SD				2.39	.890

Finally, this needs assessment survey revealed that in terms of personal teaching self-efficacy, the science teachers were at the high level threshold which means that their personal belief of their abilities to positively impact students' achievement was great. On the contrary, the teachers' science teaching outcome efficacy is at the neutral bracket and it shows that the teachers' expectation of their teaching influencing students' learning is moderate. They are ambivalent in their confidence to do positive work on students regardless of outside influences.

4.5 Implication and significance of the study

Needs assessment as a *priori* in designing professional development for in-service teachers is a very important tool to be used in coming up with a strategic, contextualized and sustainable teacher training interventions. The results of the needs assessment reveal the weaknesses and shortcomings of the teachers in terms of their content knowledge, pedagogical-content knowledge and the extent of their self-efficacy in teaching the subject matter. The insights drawn from the results of this needs assessment research are as follows:

- findings support the need to address various concerns related to in-service teaching practice in line with the implementation of the *K to 12* science and mathematics curriculum.
- with expanding the knowledge base of the science and math teachers, an equally important need is to develop the pedagogical content knowledge of the teachers in designing teaching-learning activities that will significantly address the goals and ideals of the science and mathematics curriculum.
- the learners are the ultimate beneficiaries of the entire process, as teachers will be provided with strategic intervention for professional development accordingly to their needs, would enhance their pedagogical content knowledge and self-efficacy beliefs in teaching which may eventually lead to greater confidence and exemplary teaching in the classroom, and consequently, improved student learning outcomes.

Practically, this research study advocates the need for professional development program that is flexible, needs-based, more coherent, relevant and sustainable to accommodate the different needs and aspects of teaching *K to 12* science and mathematics subjects. Furthermore, a more relevant model for teachers' professional development must associate teachers' needs and current practices with the pedagogical approaches of the K to 12 science/mathematics curriculum.

5. Conclusions

The results of the needs assessment survey indicate the need for various forms of professional development for in-service science and mathematics teachers to enable them to respond to the challenges of the K to12 Basic Education reform. First, there is the need to look into teachers' pre-service preparation and continuing professional development. While majority of the teachers have baccalaureate degrees for teaching in their major fields, very few of them have proceeded with graduate programs specializing in either science or mathematics education. Instead a number of teachers pursue graduate studies in other disciplines such as guidance and counseling, administration or human resource management. With the senior high school program in full implementation, science and mathematics teachers must be well equipped with the pedagogical content knowledge to be able to teach in this level effectively.

Second, with the implementation of the spiral curriculum in the K to 12 Education Program, teachers have significantly expressed the need to strengthen and expand their content knowledge base among the different subject topics of science and mathematics curriculum. For mathematics teachers, Statistics and Probability is the area recognized as the greatest urgency for professional development, followed by Geometry. On the other hand, for science teachers, it is the Physics domain, followed by Chemistry that was identified by the teachers as the areas that needs more development. The need to focus on these areas must be of utmost priority in coming up with a sustainable and continuous professional development programs.

Third, the results indicate the need in retooling the science and mathematics teachers in terms of the constructivist pedagogical approaches for them to attain the goals and standards in the *K to 12* Science and Math curriculum. This specifies the necessity in capacitating teachers to be able to design more engaging activities from a constructivist pedagogical framework.

Lastly, the self-efficacy beliefs of the teachers in teaching science/mathematics were moderate to high levels. This implies a promising disposition of the teachers enroute for their professional improvement in terms of content knowledge and pedagogical competencies in teaching science and math effectively. Their positive disposition toward improving their teaching capacities through continuing professional development such as a certificate program for teaching in their respective fields was highly evident in the survey and workshop interactions.

5.1 Recommendations for Future Directions

The University of San Carlos Science and Mathematics Education Department (USC SMED) is a member of a consortium network of universities in the country who served as delivering institutions for the scholarship programs offered by the Department of Science and Technology Science Education Institute (DOST-SEI) for teachers to pursue Master's and Doctoral programs in science/mathematics education. Though the scholarships are a great opportunity for science and mathematics teachers to pursue advanced degrees related to their field, the scholarship slots are limited and the selection process has become very competitive. Thus, there is a need for intermediary professional development programs for in-service teachers who may not be able to pursue long graduate programs while they continue teaching in their respective schools. This is further supported by the results of teachers' preferred mode of professional development program in which most of the respondents find short-term certificate programs as a more feasible option for enhancing their content expertise and pedagogical skills.

In view of the findings of this need assessment study, we recommend the following actions for future directions:

- Review, revision and upgrading of past certificate programs for teaching science/mathematics to align with the identified needs of the science/mathematics teachers in line with the implementation of the *K to 12* science and mathematics curriculum in basic education. These certificate programs must be anchored on the needs identified in this study and grounded on the pedagogical approaches stipulated in the *K to 12* Basic Education program.

- Updating past teacher-trainers and recruitment of new teachers to comprise the pool of teacher-trainers for the certificate programs. These teacher-trainers may be a mix of science/mathematics teachers at tertiary level and in basic education.

- For a long-term plan, a full range of options for various teacher development programs for science and mathematics teachers can be considered starting with short-term courses to certificate programs and graduate degree programs for science and mathematics teachers. While most of these programs are currently offered, there is need to look into possible revisions and updating as well as the need to build up a pool of faculty experts who serve as resource persons in the program delivery. Further, we recommend the need to consider various modes of delivery of these programs to include the optimal utilization of technological platforms for teaching and learning, such as blended-learning, flipped classroom models and other technology mediated-delivery modes.

- Integrate research with teacher development. Reflective practice and research-based models may be considered where evidence of teachers' growth and improvement over a period of time are documented through lesson study and action research approaches.

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