

Emerging Inclusive Praxis in Mathematics Education Towards an Inclusive Pedagogy

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Abstract : United Nations Conference on Sustainable Development includes SDG #4 Quality Education which lays the foundations of inclusive education which proposes that all learners should be provided with equal access to education regardless of gender, socio-economic status among others. This research explores the teacher's pedagogical content knowledge (PCK) as manifested in the inclusive practices of teachers in Mathematics. Using a case study design, twelve grade 6 Mathematics teachers from different public and private schools under a chosen division in the southern part of Manila were the participants of this study. Interview and focused group discussion were the procedures used to gather the data and a thematic data analysis was employed. It was found out that the teacher's PCK in mathematics education were manifested in the inclusive practices of the teachers starting from designing of the lesson to implementation, remediation, and assessment. Teachers provided differentiation for boys and girls on selected teaching strategies and activities as accommodation for diverse students. Differentiations happen in the actual curriculum implementation as initiated by the teachers when they facilitated their lesson in Mathematics. Furthermore, the research study provides inputs to the body of knowledge on curriculum and teacher's pedagogy.

IndexTerms – gender differences, inclusive education, inclusive practices, mathematics education, PCK.

I. Introduction

Mathematics is a subject regarded by many as an abstract and difficult as revealed in the study of Brannon & Van de Walle (2001), making students perceived the subject no meaning and has nothing to do with their real life. Such perception initially develops during elementary school where most of the learners finds Mathematics as highly abstract and heavily relies on algorithm, eventually resulting in failure of understanding and appreciating the subject. This trend is expected to continue in the junior and senior high school and college. Hence, Countryman (1992) asserted that by the time students get to high school they have lost interest in mathematics and they cannot explain some of the concepts of mathematical operations. Situation like this result to poor performance of Filipino students in Mathematics.

In the recent results of Programme for International Student Achievement (PISA) in 2018, Philippines ranked 77 out of 78 participating countries with a mean score of 353 equivalent to below level 1. Furthermore, in the Third International Mathematics and Science Study (TIMSS) in 2003, the Philippines ranked 41st out of 45 countries in Mathematics. Results of these rankings provide a great opportunity for the educational planners and curricularists in the education department. The call to closely look at the mathematics curriculum program and its implementation is imperative.

One of the areas of curriculum implementation in mathematics education that is probably being neglected is the implementation of the inclusive mathematics education. Although there were initiatives from the Department of Education (DepEd) to lay out procedures and policies in the implementation, monitoring and assessment of such implementation seemed to be lacking. Absence of formal studies and research on the area of inclusive practices in mathematics education provides a great opportunity for research engagement.

With this at hand, the need to revisit the current approaches, practices and pedagogies of teaching Mathematics right from the basic education be conducted. Hence, this study aims to examine the practices of Mathematics teachers in terms of their content knowledge, pedagogical knowledge, and pedagogical content knowledge towards inclusive practices in the implementation of Mathematics education.

The research is anchored on the theory of Pedagogical Content Knowledge by Shulman. Shulman's PCK has been used in varied research to explore its implications in Mathematics education. The theory covers conceptual, procedural knowledge, and the stages of developing understanding to mastery in order for the teachers to teach effectively (Puteh, 2014).

The figure below shows the conceptual framework of PCK and its implications to the inclusive practice of Mathematics teachers as used in this study.



Figure 1 Conceptual Framework

The study sought to answer the following research questions:

1. How do Grade 6 Mathematics teachers manifest content knowledge through structuring knowledge in response to student diversity?
2. How do Grade 6 Mathematics teachers manifest pedagogical knowledge when they facilitate and implement structured knowledge to accommodate student diversity?
3. How do Grade 6 Mathematics teachers manifest pedagogical content knowledge to harmonize content and strategy to support student diversity?
4. How can pedagogical content knowledge of Grade 6 Mathematics teachers manifest inclusive education?

II. Methodology

This study employs a qualitative inquiry following a case study design. Twelve Grade 6 teachers from public and private elementary schools in one of the Divisions of the Southern part of Manila handling Mathematics subject were the respondents of the study. The research was conducted during the third quarter of school year 2019-2020 in Mathematics 6 with the topic on angles and angle measurement. The respondents were chosen using a purposive sampling.

Table 1 shows the profile of the respondents of this study.

Table 1

Profile of the Respondents

	Number of Respondents	Percent
Gender		
Male	2	16.67%
Female	10	83.33%
Educational Attainment		
Bachelor's Degree	7	58.33%
Masteral Degree	3	25.00%
Doctorate Degree (with units)	2	16.67%
Years in Service		
less than 5 years	3	25.00%
5 years and more	9	75.00%
Type of School		
Private	6	50%
Public	6	50%

The letter of information and permission to conduct the study was sent to the office of the Division Superintendent of the chosen Division in DepEd. When the letter was approved, the letter to the corresponding school principals were distributed. Informed consent was given to the respondents of the study. Upon the signing of the consent, the interview, focused group discussion and observations were conducted. Utmost confidentiality and privacy of the respondents were ensured.

Interview, classroom observation, and focused group discussion were used to gather the data. The instrument used for the interview was composed of two parts. The first part was focused on the teacher's profile and the second part was composed of the open-ended questions. During the focus group discussion, five essential questions were given. Follow up questions to clarify the context of the answers were also provided to ensure that the data reaches its saturation point.

Thematic analysis and coding technique were utilized in the data analysis. The responses of the participants in the study were transcribed. The transcribed data were then coded and analyzed according to themes. The emerging themes obtained from the data are presented in Table 2.

Table 2

Emerging Themes Generated from the Study

Variables of the Study	General Themes	Emerging Themes	Sub-Themes
1. Content Knowledge	Manifesting Content Knowledge by Structuring Knowledge in Response to Student Diversity	<ul style="list-style-type: none"> • Designing lessons in Geometry • Sequencing of lessons • Simplifying lessons/chunking • Dealing with Unfamiliar Content 	<ul style="list-style-type: none"> • following curriculum guide • following teacher's guide • selection of appropriate materials <ul style="list-style-type: none"> - concrete objects - powerpoint - books - manipulative and visually appealing materials • selection of teaching strategies • understanding the nature of the learners <ul style="list-style-type: none"> - prior knowledge - interest • general to specific • easy to difficult • vertical articulation • basic to more complex • simple to most difficult • lesson prototyping • research • review previous materials • consultation with peers, expert in the field and immediate superior
2. Pedagogical Knowledge	Manifesting Pedagogical Knowledge to Facilitate and Implement Structured Knowledge to Accommodate Students' Diversity	<ul style="list-style-type: none"> • Addressing Gender Differences • Concretizing Lessons 	<ul style="list-style-type: none"> • Remedial program • Buddy-buddy system • Think pair share • Groupings • Use of games/songs/videos • Probing • Real life application • Problem solving • Variety of activities • Use of technology • videos
3. Pedagogical Content Knowledge (PCK)	Manifesting Pedagogical Content Knowledge to Harmonize Content and Strategy to Support Student Diversity	<ul style="list-style-type: none"> • Promoting Students' Interest 	<ul style="list-style-type: none"> • Use of differentiated activities • Mind twisters • Singing songs • Online games and drills • Group works • Giving math trivia • Participation to contest • Using localized materials • Reward system
4. PCK and Inclusive Pedagogy	Manifestation of Pedagogical Content Knowledge in Inclusive Education	<ul style="list-style-type: none"> • Promoting Students' Interest 	<ul style="list-style-type: none"> • Remedial lessons • Peer mentoring • Extra thinking time • Personal follow-up

III. Results and Discussion

The following discussions present the results of the study which are anchored on the four general themes obtained from the answers to the following research questions:

RQ#1 How do Grade 6 Mathematics teachers manifest content knowledge through structuring knowledge in response to diverse students?

Grade 6 Mathematics teachers manifest content knowledge to respond to the diverse students. When teachers design the lessons, they consider both boys and girls in the selection of the activities, teaching strategies and types of assessments. However, in sequencing of lessons and dealing with unfamiliar content, the teachers do not consider the differences between girls and boys. Moreover, when teachers do lesson chunking to simplify the seemingly difficult topics, they consider boys and girls. The following discussion presents the details of the findings:

a. Designing Lessons in Geometry (point out the knowledge to address gender)

In designing lessons in geometry, it is a common practice among the participants to anchor the content on the objectives enumerated in the curriculum guide. The daily lesson log is prepared following what is indicated in the teacher's guide. Also, appropriate instructional materials and teaching strategies are selected to cater to the nature and individual needs and interests of the learners, as well as their level of thinking. Most of the participants resort to the use of realia, textbooks and other printed materials, and visually appealing commercial manipulatives. Furthermore, pre-tests are administered to check on the students' prior knowledge of the concept to be learned.

b. Sequencing of Lessons

Most of the participants arrange their lessons from specific to general. They also argued that they sequence their lessons from the easiest to the most difficult in support to the spiral progression technique, and use learners' prior knowledge as the foundation upon which the learning of new concepts shall be built, which essentially determines the pre-requisites or related skills needed in comprehending a new lesson. Lastly, the skills are patterned on what the Department of Education requires as enumerated in the curriculum guide.

c. Simplifying Lessons/Chunking

The participants simplify their lessons by beginning with the basic concepts to the more complex ones. In doing so, the learners are able to see the relevant and meaningful connections between the existing and the new knowledge. Basic concepts in Geometry are introduced in the lower grades to facilitate higher learning of Geometry lessons in the succeeding grade levels.

Further, they follow the prototype lesson plan, which shows the division of topics and lessons to be taught and execute such using PowerPoint presentations and realia.

Finally, lessons are simplified by applying teaching strategies parallel with the needs, readiness and abilities of their learners.

d. Dealing with Unfamiliar Content

When confronted by an unfamiliar content prior to the delivery of instruction, the participants claim to aid themselves by researching about the topic on the Internet and/or using other reference materials to consider simple and concrete examples to supplement their understanding thereof. Also, revisiting previous topics or pre-requisites concretizes their familiarity with the content. Finally, they consult with other math teachers or subject area coordinators as they are deemed experts in the same field.

Participants of this study generally consider boys and girls in the design of the lesson, sequencing, simplifying and chunking of difficult topics. Varied teaching strategies and activities were facilitated to ensure that diverse students are being considered. Hence, teachers must be well-versed in the formulation and designing of the lesson. When teachers are trained in such area, effective selection of activities and strategies would provide positive impact. This result is supported by studies of Bones and Lambe (2007) and Kuyini and Desai (2008) which reported that teacher's training on facilitation for inclusive education provide positive impact on diverse learners. Although the participants do not consider the differences between boys and girls in dealing with unfamiliar content, the participants ensured that variety of learning materials are provided to them.

RQ#2 How do Grade 6 Mathematics teachers manifest pedagogical knowledge when they facilitate and implement structured knowledge to accommodate diverse students?

The teachers manifest pedagogical knowledge as they facilitate and implement the structured knowledge to accommodate diverse students. They addressed the gender differences in the class through the implementation of the different programs like remedial, buddy-buddy system, think-pair-share among others. As they concretize the lessons, they consider learning activities most suited to boys and girls.

The following discussions show the manifestation of pedagogical knowledge of teachers considering diverse students:

a. Addressing Gender Differences

When it comes to gender differences in the classroom, the answers of the participants may be categorized into two: one is that lessons are adapted to the gender of the learners when the need arises especially during remedial sessions, and the other one is that the gender differences are not taken into consideration at all as what is more considerable is the nature of the learner, whether fast or slow, as opposed to his or her gender. *Boys vs Girls schemes* is one of the games that manifests gender differences in the classroom plus the groupings done during collaborative work in order to address such.

b. Concretizing Lesson

In concretizing abstract concepts, the participants pose probing questions upon the learners on how the latter may apply the concepts learned to everyday life as this also enables them to determine and appreciate the importance and see the relevance of the lessons when brought outside the classroom in their everyday living. The learners are likewise presented with concrete situations grounded on problem solving in addition to technology integration and the use of supplementary materials such as but are not limited to visual presentations, diagrams, and real objects, which essentially concretize abstract ideas as well. Teachers always consider boys and girls as they employ these learning activities and classroom strategies.

The teachers ensured that the differences among boys and girls in the class through the facilitation of the structured knowledge are addressed. They implemented systems and procedures to accommodate the nature of boys and girls in the class. These systems and procedures are manifested in their remediation, probing, application of the structured knowledge to the student's real-life situations, and even in the use of technology. Although teachers used measure to address both boys and girls in concretizing the seemingly difficult content, considerations were made through a variety of activities. Teachers did not find one most effective activity for boys or girls but through the implementation of these varied activities in the classroom. Teacher's PCK play a vital role in the selection, design, and implementation of activities in mathematics to provide impact learners considering both boys and girls. This finding is supported by the study of Basturk and Donmez (2011).

RQ#3. How do Grade 6 Mathematics Teachers manifest pedagogical content knowledge to harmonize content and strategy to support diverse student?

Teachers supported the student's interest in mathematics as a manifestation of their PCK through harmonizing content and strategy. The teachers facilitated their support to student's interest in the selection of the strategy which are appropriate to the gender of the learners.

Manifestation of PCK to harmonize content and strategy to support student diversity were done through promoting students' interest. The participants have been arousing learners' interest in math concepts when introducing learning activities that would excite the learners through various learning engagements such as singing a math song composed by the teacher himself/herself, playing a game, or watching a video presentation, alongside the application of differentiated and localized instruction, collaborative activities, and online educational games supplementary to the teaching-learning process. Further, reinforcement in the form of rewards and appreciation of a job well done is employed by the participants. Teachers shared that the nature of boys and girls probably provide differences in terms of their reading comprehension which influenced their mathematical abilities. Hence this provide a great deal of challenge to teachers in harmonizing content and strategy. This is similar to the findings of Anjum (2015) which reported that there is a significant correlation between mathematics achievement and reading comprehension and a difference between boys and girls was found.

RQ#4 How do Grade 6 Mathematics teachers manifest PCK in inclusive education?

PCK was manifested in inclusive education as the teachers provide support to students' learning. Teachers provide support to boys and girls in various ways. The initial step is to identify the struggling learners and talk to them in private. The parents are also informed of the matter at hand. Having done so, the participants employ remedial instruction during vacant periods and apply intervening measures matched with the said learners' needs, level of understanding and interests such as pair work activities, peer mentoring sessions, Feed Forward Instruction, among others. Participants consider both boys and girls in the selection of the appropriate intervention approaches. This is parallel to the findings of the study of Ajai and Imoko (2015) while it opposed the findings of Fennema and Leder (1990) that difference mathematics achievement of boys and girls is dependent to cognition of boys and girls.

IV. Summary, Conclusion and Recommendation

The study aims to explore the manifestations of the teacher's PCK in the inclusive practices in Mathematics education. In identifying these manifestations on inclusivity, the study considered boys and girls as category of diverse learners. The summary of findings are presented below:

1. Teachers manifest inclusive practices on content knowledge through designing, sequencing, simplifying/chunking, and dealing with unfamiliar content of the lesson.
2. Teachers manifest pedagogical knowledge through addressing gender differences and concretizing lessons.
3. Teachers manifest pedagogical content knowledge through promoting student's interests.
4. Teachers manifest pedagogical content knowledge in Inclusive pedagogy through supporting students learning.

This study hypothesized that the teacher's PCK could be manifested in inclusive practices in Mathematics education. This study concludes that PCK in mathematics education were manifested in the inclusive practices of the teachers starting from designing of the lesson to lesson implementation, remediation, and assessment. This study focused on manifesting PCK in diverse learners considering boys and girls, hence, grade 6 teachers in Mathematics provided differentiation on selected teaching strategies and activities to accommodate this diversity. These differentiations happen in the actual curriculum implementation initiated by the teachers as they facilitate their lesson in Mathematics.

Based on the findings of the study, the following recommendations are made:

1. emerging pedagogy may become a basis in revisiting the practices of teachers for possible improvement and formulation of the existing policies to address the needs of diverse learners in the delivery of instruction in Mathematics discipline.
2. findings of this study may be used to prompt the Department of Education in implementing inclusive education as basis for reengineering and restructuring the capability programs for mathematics teachers enabling them to become adept on how to effectively teach mathematics addressing diverse students in the class.
3. a more comprehensive study be conducted to identify inclusive practices considering all other aspects of inclusivity and diversity of learners.

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