

Mathematics Process Skills of Teachers through Continuing Professional Development (CPD)

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Abstract: *This study aimed to design and evaluate the effectiveness of a Continuing Professional Development (CPD) program on mathematics process skills for teachers. The study utilized a descriptive-developmental research design and employed a process skills test, pretests, and posttests, as well as qualitative analysis using thematic analysis to gather data. The findings revealed that the developed CPD program, consisting of pre-implementation, implementation, and post-implementation phases, effectively improved teachers' mathematics process skills. The program was based on the ADDIE model and showed significant improvement in skills such as observing, classifying, inferring, predicting, measuring, communicating, interpreting, analyzing data, experimenting, making conclusions, and defining operationally. The three-day training-workshop had a significant impact on teachers' perception and understanding of process skills. The study derived a CPD model called the PIP-CPD model, emphasizing the interconnectedness of the three phases. Based on the conclusions, recommendations include continued implementation and refinement of the CPD program, expanding and sustaining professional development opportunities, providing ongoing support and resources, encouraging reflective practice, fostering collaboration and peer learning, and monitoring and evaluating the impact of the program.*

Keywords: Mathematics Process Skills, Continuing Professional Development (CPD)

1. Introduction

An undertaking to be meaningful should manifest the commitment of providing quality education. Educators for several years have noticed that a lot of challenges and circumstances had wrenched the portals of achieving the mission and vision of the Department of Education on serving its clientele, the learners. A lot of factors had been considered as essential for providing quality service to the learners where the teachers had focal responsibility of achieving such, with the guidance and support of the school management. Teachers should be given sufficient support where design of efficient and effective continuing professional program must be considered.

Today's society demands that teachers' function must have an impact in the lives of their students and the society. In-service training for teachers is aimed at the improvement of current teaching practices towards professional competence and the perennial aspect in the life of teachers is learning. A teacher hampers student achievement in the absence of continuous growth for them (Alviz, 2019). Srinivasacharlu, (2019) also pointed out that the complexities of the 21st century required that teacher educators need to pursue continuous professional development to avoid being outdated, alienated and helps them improve their personality continually and do justice to the teaching profession and society. The teacher is the backbone of the education system and is the architect of the society. The progress of an organization in education, depends upon the quality of its teachers.

Paying more attention to the continuing professional development of teachers that promotes quality education in school is considered an essential component for creating a positive impact on their pedagogy and teaching practices (Sabah, Fayez, Alshamrani & Mansour, 2014). Hyatt (2017) emphasized the importance of Continuing Professional Development (CPD) as part of teachers' education and would keep them updated on their professional knowledge and skills. It also helps teachers to learn new techniques in

teaching students of this generation and grow professionally while improving their classroom skills. CPD will let teachers stay in touch with the latest development in the education sector and help them change their way of teaching especially to those teachers who have been in the profession for many years who are usually reluctant to change their teaching styles.

There is also an intersection of Process skills and 21st century skills for the process skills used by the students in conducting research and experiment that involves basic skills such as observing, classifying, making inferences, predicting and communicating and leads to higher thinking skills such as critical thinking and problem solving skill, by interpreting and analyzing data, making hypotheses and conclusions, that clearly states that process skills and literacy are needed in fostering 21st century skills. (Turiman et al, 2011)

The participation of the Philippines in the 2018 Programme for International Student Assessment (PISA) revealed disheartening results, with the country ranking last in reading and second to last in Science and Mathematics among 79 participating countries. This outcome emphasized the pressing need to address the quality of basic education in the Philippines. According to the findings, a significant majority of students (78%), accounting for 95% of the Philippine students represented in PISA, failed to achieve the minimum level of proficiency in reading, science, and mathematics. The study identified three crucial policy areas to enhance the foundation for effective learning. One of these areas involves transforming the role of teachers to better support student learning. This transformation entails strengthening the career advancement system to improve the quality of teachers and school leaders. It recognizes that teachers have a responsibility to address the individual needs of students, requiring not only subject knowledge but also socio-emotional competencies and classroom management skills. As a result, providing continuous professional development to teachers is essential, covering a wide range of skills (Kataoka & Alejo, 2020). Moreover, to achieve

high scores in the Trends in International Mathematics and Science Study (TIMSS), students must enhance their mathematical learning process (Skoumies and Skompomdi, 2021)

The Department of Education issued Deped Memorandum No. 50, s.2020 last May 4, 2020, entitled Deped Professional Development Priorities for teachers and school leaders for school year 2020-2023, pursuant to Deped Order no. 001, s.2020 titled Guidelines for NEAP Recognition of Professional Development Programs and courses for teachers and school leaders through the National Educators Academy of the Philippines (NEAP), emphasized that the Professional Development priorities shall support the realization of the Department of Education's goal of continuous upskilling and reskilling of teachers and school leaders that will result in better learning outcomes. The enclosure of the memorandum provides the professional development priorities for teachers reiterates that teachers should use a range of teaching strategies that enhance learner achievement in literacy and numeracy skill, and apply a range of teaching strategies to develop critical and creative thinking, as well as other higher order thinking skills, as what the k to 12 curriculum gives emphasis on the necessary skills that students nowadays needs to developed. (Republic Act No. 10533)

Based on DepEd Order No. 127, s. 2016, issued on August 16, 2016, the Bureau of Education Assessment of the Department of Education has mandated the assessment of process skills in mathematics among teachers. This assessment serves as the basis for designing a continuing professional development program. The order stipulates that the Teachers' English Proficiency Test and Process Skills Test should be administered to all Grade 7 and 8 public school teachers who teach science and mathematics subjects.

In line with this, the Schools Division of Sorsogon released Division Memorandum No. 72, s. 2017 on June 27, 2017, which mandates all Grade 7 and 8 teachers teaching science and mathematics to take the Teachers' English Proficiency Test and Process Skills Test. The examination was scheduled to be held at Casiguran Technical Vocational School on July 23, 2017.

Furthermore, considering the alarming results of the Philippines in previous international assessments such as PISA in 2018 and TIMSS, both of which are considered process skills tests, this study will contribute to improving students' performance in process skills.

Research Questions

The study aimed to develop and evaluate the effectiveness of the continuing professional development (CPD) program on mathematics process skills of teachers. As such, this study sought answers to the following research questions:

- 1) What continuing professional development (CPD) program could be developed to improve the mathematics process skills of teachers?
- 2) How effective is the CPD in improving the process skills of the teachers?

- 3) What are the significant learning experiences of teachers on the implementation of the continuing professional development (CPD)?
- 4) What CPD model can be derived from the study?

2. Methodology

Research Design

This study utilized descriptive-developmental research design. The Process skills test results were analyzed and used as basis of the developed continuing professional development program and determine the significant difference between the pretest and posttest of the teachers on Process skills before and after the conduct of continuing professional development program. Also, the researcher examined the significant learning experiences of teachers with the designed CPD program based on their reflections during the training-workshop and the implementation of the CPD on teaching-learning in mathematics, as part of the qualitative analysis using thematic analysis.

Kothari (2004) defines descriptive research design as those studies which are concerned with describing the characteristics of a particular individual, or of a group. Also, it concerned with specific predictions, with narration of facts and characteristics concerning individual, group or situation. Bueno (2016) defined developmental method that investigate patterns and sequences of growth and/or change as a function of time. In this study, the data being investigated was the significant learning experiences of the teachers from the time they attended the training workshop to the implementation on the learning they acquired on the teaching-learning process in mathematics applying the mathematics process after the first quarter of school year 2022-2023.

The Sample

There are 190 Grade 7 and Grade 8 teachers teaching Mathematics in the Division of Sorsogon whom are the target respondents of this study. The proponent utilize cluster sampling since there are two congressional districts in the Province of Sorsogon. The first congressional district includes the municipalities of Casiguran, Castilla, Donsol, Pilar, and Magallanes, while the second congressional districts includes the municipalities of Bulan, Barcelona, Bulusan, Irosin, Gubat, Matnog and Prieto Diaz. The teacher-respondents were identified after cluster sampling using purposive sampling where the basis is, for those teachers in the first and second congressional district and those who took the Process Skills test.

There are eight (8) or thirty-four and seventy-eight hundredths percent (34.78%) teacher-participants from the first congressional districts while eighteen (15) or sixty-five and twenty-two hundredths percent (65.22%) teachers from second congressional district. This is due to the restrictions on their place and there is also an activity from their respective schools. Out of twenty-three (23) teachers, one teacher-respondents or four and 35 hundredths percent (4.35%) comes from the Municipality of Barcelona, five (5) out of twenty-three (23) or twenty-one and seventy-four hundredths percent (21.74%) from Municipality of Bulan, three (3) or thirteen and 4 hundredths percent (13.04%)

comes from Municipality of Bulusan, three (3) or thirteen and 4 hundredths percent (13.04%) comes from Municipality of Irosin, two teacher-respondents or eight and seventy hundredths percent (8.70%) comes from Municipality of Castilla, three (3) or thirteen and 4 hundredths percent (13.04%) comes from Municipality of Casiguran and one teacher-respondents or four and 35 hundredths percent (4.35%) comes from each Municipalities of Donsol, Gubat, Matnog, Magallanes, Prieto Diaz and Pilar. Only the Municipality of Sta.Magdalenita that has no teacher-respondents who did not took the Process Skills Tests. On the other hand, thirteen or fifty-six and fifty-two hundredths percent (56.52%) from among the participants are Teacher III, nine or thirty-nine and thirteen hundredths percent (39.13%) are Teacher I and only one Master Teacher I or four and thirty-five hundredths percent (4.35%) who attended the three-day training-workshops. From among the teacher-participants, there are twelve (12) Grade 7 teachers or fifty-two and seventeen hundredths percent (52.17%) of the total participants, while there are eleven (11) Grade 8 teachers or forty-seven and eighty-three hundredths percent (47.83%) who participated. The ages of the teacher-participants range from 28 to 57 years old. (see annex no. 6 on page 170 of the list of appendices)

The Instrument

The improvement of this undertaking was realized through the instruments utilized on different phases of the development and design of the continuing professional development. The proponent secured copies of the results of the Teachers English Proficiency Test-Process Skills test (TEPT-PST) conducted by the Bureau of Educational Assessment last July 23, 2017 in the Division of Sorsogon to determine the proficiency level of mathematics teachers in the Process Skills Test using documentary analysis. The results was presented along with the Learning and Development Needs Assessment Plan (LDNA) that consists of the rationale on the assessment of the need to conduct the continuing professional development program along with the target participants, learning objectives, target start and end of LDNA, course title, the demographics of the participants (including the target job groups, offices and positions), the methodologies (sampling method and sample size, data required, data gathering methods, LDNA tools and respondents/sources), and the implementation details. (Please see attached sample of LDNA on page of the appendices and the results of TEPT-PST on page of the appendices). The planning of the CPD involves the creation of the division memorandum no. 095, s.2022 and the Authority to Conduct of the CPD dated May 30 2022, these documents were served as wide dissemination of information pertaining to the implementation of the CPD and that the conduct of CPD were approved by the persons in-authority. The said documents were prepared through the technical assistance of the Education Program Supervisor in Math and English in the division. The division memorandum includes the target participants, the training venue and the training committees signed by the Chief of the Curriculum and Instruction Division (CID) office, recommending approval of the Assistant Schools Division Superintendent and approved by the Schools Division Superintendent. The Authority to Conduct (ATC) includes the Activity Design/Program of Activities, detailed financial

requirements and the Training Matrix. (see attached copy of the division memorandum 095 s.2022 and Authority to Conduct on page of the appendices). As part of the training matrix, the pretest and posttest were also utilized to determine the effectiveness of the CPD which was adopted from the office of the Curriculum and Instruction Division, the preparation of the table of specifications as to the process skills used per item were done through a focus group discussion involving education program supervisors, division coordinators, master teachers and teachers in mathematics and science, based on the solutions provided on the key of correction. (See attached copy of the sample pretest/posttest on page , Table of Specifications (TOS) on page , and key to correction on page of the appendices). To assess the quality of the conducted CPD, different QAME (Quality Assurance Monitoring and Evaluation) tools were also utilized which was provided by the Schools Governance and Operations Division (SGOD) office, which includes M&E tool No. 1: Session-Facilitators Evaluation Tool which was utilized to assess if the target objectives per session were met and effective and if the facilitators are knowledgeable with their topic, M&E tool no. 2: End Program Evaluation were utilized to assess if the flow of the program or matrix were achieved, how the content were delivered, training venues and meals, and the management team. M&E tool no. 3: Process Observation tool were utilized to assess the session content, session process, session atmosphere and the participation of trainees, M&E tool no. 4: On-site Monitoring and Evaluation were utilized to assess the program delivery including critical incidents if it may occurred , M&E tool no. 5: Daily Operation Evaluation used to assess the training venue/site, meals and program management team and M&E Template no. 1: Focus Group Discussion used to accomplished the things appreciated from the training workshops, things considered need improvement and suggestions to improve the session/workshop. The summary and results of the different evaluation tools were presented and reported using the QAME Analysis Form 1 and 2. (Sample and copies of the different QAME tools were on pages of the appendices). For the thematic-analysis of qualitative data on learning experiences of teachers during the conduct of CPD and upon the implementation of the CPD on the teaching-learning process in the classroom, a survey questionnaire and structured interview was utilized (see attached copy on the annexes on pages 143 and 146). The survey questionnaire and structured interview were designed through the technical assistance of the Education Program Supervisor in Mathematics, Science and English to maintain its veracity, consistency and reliability.

Data Collection Procedure

A letter was submitted to the Schools Division Superintendent asking the copy of the results of the Teachers English Proficiency Test- Process Skills Test (TEPT-PST). After which, the results were then tabulated and analyzed and served as the basis for designing a Continuing professional development program. The developed CPD program were evaluated and validated by the Education Program Supervisors in Science and Mathematics and were utilized by the teachers to improve their mastery in mathematics process skills. The conduct of pretest were done before the actual conduct of the CPD on the first day of

the training-workshop, then a posttest were also conducted after three days of training-workshops taken by the selected participants who took the TEPT-PST last July 23, 2017. The QAME tools were distributed and accomplished every training session for three days, by the participants, facilitators and QAME associates. A survey questionnaire was distributed to the teachers-participants after three-days of attending the training-workshops in the Division of Sorsogon to gather information about the significant learning experiences of the teachers-respondents on the attended CPD, while a structured interview, developed by the researchers with technical assistance of the Education Program Supervisors, was distributed to the teachers in the Division of Sorsogon to gather information about the significant learning experiences of the teachers-respondents after the first quarter of School Year 2022-2023 where process skills were utilized during the teaching-learning in the classroom, after asking permissions to the Schools Division Superintendent thru the Principals of the different schools in the Division of Sorsogon.

Data Analysis Procedure

The data analysis of this undertaking involved the use of statistical tool for quantitative part of the research, and thematic analysis for qualitative part.

For quantitative data analysis, the data to be analyzed on the first objective is the utilized frequency count, mean, percentage, t-test and effect size to determine the effectiveness of the developed CPD. The level of proficiency of the teachers were identified based on the results of the process skills test during the conduct of pretest and posttest. The mean of the proficiency level of the teachers on the pretest-posttest results were computed to determine the average of the scores in each process skills and overall percentage scores, using the mean or average formula, as follows:

$$\text{Mean (Proficiency level)} = \frac{\sum x}{N}$$

where: \sum = summation

x = scores in the Process Skills test (pretest-posttest)

N = the number of teachers who took the Process Skills test pretest-posttest)

Standard deviation will also be computed to analyze the spread of scores of the teachers and to compute for the effect size. To interpret the level of proficiency, the following table, as shown in table 1, were utilized:

Table 1: Process Skills Level of Proficiency and Interpretation

Level of Proficiency	
90% - 100%	Highly Proficient
75% - 89%	Proficient
50% - 74%	Nearly Proficient
25% - 49%	Low Proficient
0% - 24%	Not Proficient

To test the null hypotheses stated where significant difference tested, the statistical test used is t-test where the difference between the pretest given before the continuing professional development program and posttest after the

three-day continuing professional development program was conducted, using the formula below:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}}$$

Where:

\bar{x}_1 – mean of the pretest

\bar{x}_2 – mean of the posttest

s_1 – standard deviation of the pretest

s_2 - standard deviation of the posttest

n_1 – sample size of test takers of the pretest

n_2 – sample size of test takers of the posttest

To tell us how meaningful the differences between two variables or the difference between groups, an effect size must be calculated. Since this study determines a significant difference between variables, Cohen's d was used to compute the meaningful differences between two variables, and determine the effect size, using the formula below:

$$\text{Cohen's } d = \frac{\bar{x}_1 - \bar{x}_2}{SD \text{ pooled}}$$

$$\text{where } SD \text{ pooled} = \sqrt{\frac{\sum(X_A - \bar{X}_A)^2 + \sum(X_B - \bar{X}_B)^2}{n_A + n_B - 2}}$$

3. Conclusions

Based on the data gathered, the following conclusions can be drawn:

- 1) The developed Continuing Professional Development (CPD) program for teachers, consisting of three phases (pre-implementation, implementation, and post-implementation), effectively improved the mathematics process skills of teachers. The CPD program was designed based on the ADDIE model, which includes analysis, design, development, implementation, and evaluation.
- 2) The results of the process skills test, conducted through pretests and posttests, showed significant improvement in teachers' process skills related to observing, classifying, inferring, predicting, measuring or quantifying, communicating, interpreting, analyzing data, experimenting, making conclusions, and defining operationally. The CPD program was found to be effective in enhancing these mathematics process skills.
- 3) The three-day training-workshop significantly impacted teachers' perception and understanding of process skills in teaching and learning mathematics. The majority of the teachers recognized the applicability and importance of process skills, their role in developing critical thinking and problem-solving skills, and their potential to improve teaching and students' performance.
- 4) The CPD program, based on the PIP-CPD model (pre-implementation, implementation, and post-implementation phases), demonstrated a comprehensive approach to professional development. The successful implementation of all three phases, including the submission of a LDNA plan, design of the CPD program, expert evaluation, three-day training workshops, pretests and posttests, and evaluation and assessment, contributed to the effectiveness of the program.

4. Recommendations

Based on the conclusions drawn from the findings, the following recommendations can be made:

- 1) Continued Implementation and Refinement: The CPD program for teachers, based on the developed PIP-CPD model, has shown positive results in improving teachers' mathematics process skills. It is recommended to continue implementing and refining this program, considering feedback from teachers and incorporating any necessary adjustments based on their experiences.
- 2) Expand and Sustain Professional Development: Given the positive impact of the three-day training-workshop on teachers' perception and understanding of process skills, it is recommended to expand and sustain professional development opportunities in this area. Offering additional workshops, seminars, and training sessions focused on process skills can further enhance teachers' competencies and their ability to effectively incorporate these skills into their teaching practices.
- 3) Provide Ongoing Support and Resources: To ensure the continued application of process skills in teaching and learning mathematics, it is important to provide teachers with ongoing support and resources. This may include access to educational materials, lesson plans, and instructional strategies that explicitly integrate process skills. Also, fostering a supportive network where teachers can collaborate and share best practices can further enhance their professional growth.
- 4) Encourage Reflective Practice: Emphasize the importance of reflective practice among teachers. Encourage them to regularly reflect on their teaching methods and the impact of process skills on student learning outcomes. Providing opportunities for self-assessment, peer observations, and feedback can help teachers identify areas for improvement and promote continuous growth.
- 5) Foster Collaboration and Peer Learning: Promote teacher collaboration and peer learning. Encourage them to share their experiences, successes, and challenges in implementing process skills in the classroom. Facilitating opportunities for collaborative planning, co-teaching, and professional learning communities can create a supportive environment for teachers to learn from one another and enhance their instructional practices.
- 6) Monitor and Evaluate the Impact: Continuously monitor and evaluate the impact of the CPD program on teachers' process skills and student outcomes. Collect feedback from teachers, conduct regular assessments, and analyze student performance data to assess the effectiveness of the program. Use this information to make data-informed decisions and further improve the CPD program.

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