Pre-Service Teachers Methods of Teaching Science

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Date Received: December 29, 2014; Date Revised: February 13, 2015

Abstract - *The study described the teaching methods used by pre-service teachers in Science. It focused on the strategies, techniques, materials, innovative methods and pattern of teaching science used by the pre-service teachers as described in their lesson plans. The qualitative and quantitative design was used in the study. The books, teacher hand-outs from classroom lectures were the sources of methods, strategies and techniques. The chalkboard and self-made drawings and charts were the materials often used. Conventional methods like lecture, open class discussion and demonstration were commonly employed. The strategies included group discussion, use of motivating questions and stories to arouse the interest of students. The direct eye contact, body expressions, jokes and news/trivia were frequent techniques. Integration of values in the lesson became less as the year level increases. The pattern of teaching drawn followed the formal style: I Objectives, II Subject matter, III Learning Tasks, IV Synthesis of the lesson, V Assessment and VI Enrichment. The conventional method and pattern of teaching by the pre-service teachers of PSU suggest that students in the College of Teacher Education should be trained to be more innovative and open in trying out more advanced teaching methods. Furthermore, PSU science pre-service teachers should use methods which can develop higher order thinking skills among high school students.*

Keywords: *Teaching methods, strategies, techniques, instructional materials*

INTRODUCTION

Quality learning among students needs quality teaching while quality teaching produces quality learning that can only be had if quality methods of handling classes are employed. The quality of teaching refers to the appropriateness of method selected to achieve the identified objectives for a certain subject matter (Duque, 2003).

The selection of appropriate method, strategies and materials among in-service and pre-service teachers is one of the difficulties in teaching. It was observed that the pre-service teachers do not have sufficient knowledge about teaching strategies, methods, and techniques and that they cannot distinguish between these concepts (Gunes et al., 2011). Observations also showed that in-service and pre-service teachers often used explanation and question-answer methods and that they do not exploit various critical thinking methods and strategies despite knowing their advantages in science.

There are methods and strategies suggested as effective modalities in teaching Science such as Initial gaming, Cooperative Learning (Tiwari, 2010), Mastery Learning, Laboratory Approach, Concept Mapping Approach, Task-based, Science-Tech-Society Approach, Audio-Visual/Tutorial Approach, Demonstration Method, Project bond Expository Method, Morrison Technique in Unit Method, Discovery/Inductive Strategy, Discovery/Deductive Strategy (Fung & Howe, 2014) Directed/Inductive Strategy, Directed-Deductive Strategy (Tiwari,2010) Discovery/ Transdirective Strategy, Directed Transdirective Strategy, Experiments, Demonstration and Role Playing (Silberman,1991). In spite of the wide range of effective modalities in teaching, studies show that lack of methodology in teaching results to the declining level of knowledge-input and analytical skills among high school and elementary students (Lardizabal, 1977).

The description and investigation of the methods, strategies, techniques and instructional materials in teaching can help the pre-service teachers explore various methods aside from the conventional types. These new methods in teaching can help improve performances of pupils/students at the same time foster critical thinking (Popil, 2011) in science. In addition, good choice of teaching method can help pre-service teachers adapt her/his teaching style to the student learning style (Iura & Neacsu, 2011) at an early stage of teaching learning.

P-ISSN 2350-7756 | E-ISSN 2350-8442 | www.apjmr.com

This study investigated the Methods, Strategies and Techniques (MST's) of teaching among *PTs* or Practice Teachers in teaching Science (General Science, Biological Science, Chemistry, and Physics) at the Pangasinan State University-Laboratory High School (PSU-LHS) during the 2nd semester of the school year 2010-2011. This study also enumerated the (1) the sources/references of the MSTs in teaching Science (2) the *IMs* or Instructional Materials used, (3) innovative MSTs described in their actual teaching if there is any and draw the flow/pattern of teaching science as observed in their lesson plan and actual teaching.

These observed modalities in teaching Science involve the teacher as one of the key persons in the science education. The teacher is directly involved in the instructional process in the classroom setting while the students learn by doing. Learning is enhanced when the frequency with which the students actively respond during instructions increases (Cioco, 2003). The teacher is also highly involved in planning and executing the lesson. The Pangasinan State University College of Teacher Education prepares teachers both for the elementary and high school thus, the findings of this study on pedagogy can help Pre-service teachers (PT) evaluate and draw the orderly procedures in teaching from planning, implementing and evaluating practices in order to produce the desired results/output skills acquired in practice teaching.

METHODOLOGY

Research Design

The descriptive and evaluative research design was used in this study. The data were described and analyzed using codes and qualitative patterns. The sources of and the innovative methods, strategies and techniques used by PTs and the instructional materials utilized in teaching science were surveyed, identified and described by the PTs. The descriptions were coded and analyzed for existing commonalities. The innovative methods, strategies and techniques used by student teachers were described based on a questionnaire, their actual teaching, and the observations made by the supervising instructors. Similar answers in the questionnaire and similarities in their lesson plans were tallied, compared, coded and validated.

Respondents

The subjects of this study were the 28 PTs who were on their on-campus student teaching during second semester of the school year 2010-2011. There were 3 male and 7 female General Science majors, 4 male and 7 female Biological Science majors, 2 male and 2 female Chemistry majors and 2 male and 1 female Physics majors comprising the total number of 28 respondents.

Instrument and Procedure

The instruments consisted of questionnaire-checklist and interview guide. The questionnaire was divided into three parts: (1) the Practice teachers' sources/references; (2) materials used in teaching; and (3) description of their MSTs in teaching science. Open ended questions followed after each checklist to validate their answers. The instruments were validated by three Science Professors of PSU and were pilot tested.

Permission was sought from the principal prior to the conduct of interviews. The 28 science PTs were observed and interviewed by the researchers after the class. . The researchers also gathered 32 lesson plans to determine the pattern of teaching methods. The three supervising instructors and some students were also interviewed on the innovative MSTs used by PTs in their teaching. Probing questions were asked for triangulation and for justifying answers in the checklists. During the administration of the questionnaire, the researchers explained to the PTs the objectives of the study. The 32 lesson plans of the respondents were analyzed and coded to extract the pattern of teaching.

Data Analysis

The descriptions during the interview and answers from the questionnaire were coded and tallied for commonalities. Frequency count and percentages were used to analyze the sources or references, instructional materials, methods, strategies, and techniques used during actual teaching and written in the lesson plan.

RESULTS AND DISCUSSIONS

The data are presented into six topics, namely: 1.) Sources/References; 2.) Instructional Materials Used; 3.) Methods; 4.) Strategies; 5.) Techniques; and 6.) Pattern/Flow of Teaching.

For teaching to be effective, a teacher should not only have ability to teach, but should also be able to carry out the teaching learning process using the different resources available in his environment. These references aid them in teaching the lesson.

P-ISSN 2350-7756 | E-ISSN 2350-8442 | www.apjmr.com

Table 1. Sources of Methods, Strategies and Techniques (MSTs) Used by Pre-service Teachers

Sources	f	%
Books	27	96
Instructors' Handouts/Study Guide	21	75
Classroom lectures	21	75
Internet	20	71
Science Magazines/Journals	20	71
Methods recommended by friends	17	61
Methods recommended by mentors	13	46
Prototype Lesson Plans	13	46
Science education journals	12	43
Newspapers	8	29
Lecture from seminar/workshop	6	21
Television	6	21
Radio	2	7

Table 1 above shows, the sources of MSTs used by PTs. The books, teachers' handouts, Internet, classroom lectures, Science Magazines/Journals and methods recommended by friends were the common sources of MSTs; however, lecture from seminar/workshop, Television and radio were seldom used as resources. Majority of the respondents selected books. PT 4 said that, books/textbooks are considered major sources of MSTs in teaching because they are readily available. The PTs also added that books were used by them to enrich their knowledge, gain more insights, and enlighten their minds regarding MSTs in teaching. According to some of the PTs, the teacher handouts and classroom lectures are some of their primary source of MSTs because they are simple and easy to understand. The Internet or electronic source is also a popular source for innovations of MSTs, because of its accessibility and the vast array of information it provides. On the other hand, the data access for ideas on MSTs from published international indexed science education journals is limited due to lack of online subscriptions.

Instructional Materials (IMs) Used in Teaching Science Subjects

Knowledge transfer is a vague job for teachers without the use of materials. These materials can make teaching complexities become simple. Audio-visual aids are the general types of materials being used in teaching. The use of these materials in the process of teaching can be effective in arousing the students' interest on the subject matter. To upgrade the quality of teaching-learning effectiveness, instructional materials are an important factor in attaining the objectives of the lesson (Acero, 2000) and making understanding more feasible for the students.

Table 2 reveals, that majority of the PTs used chalkboards, self-made drawings, cut out pictures in teaching science. The video tape, recorder, movies and multimedia/computer were seldom used or not used at all by General Science, Biology and Chemistry PTs. These data imply that visual aids are more used frequently than audio materials. It is noticeable that manipulative materials in the laboratory such as apparatus, specimen and chemicals were sparingly used except for Physics. These commonly used visual materials do not support the idea that learners easily grasp the meaning of the lessons presented when all their senses are used (Abell, 2007).

Table 2. Instructional Materials Used in Teaching Science Subjects

Materials	**Gen. Sci.**		**Bio. Sci.**		**Chemistry**		**Physics**	
	f	**%**	**F**	**%**	**F**	**%**	**f**	**%**
Radio with recorder	1	10	1	9	1	25	0	0
Chalkboards	10	100	11	100	4	100	2	67
Cut-outs or still pictures	8	80	11	100	3	75	3	100
Graphs	5	50	10	90	0	0	2	67
Charts	8	80	0	0	3	75	1	33
Maps and globes	4	40	0	0	0	0	0	0
Posters	9	90	5	45	2	50	2	67
Exhibits	1	10	2	18	1	25	2	67
Flannel/magnetic board	1	10	0	0	0	0	1	33
Live specimen	8	80	7	64	2	25	1	33
Models	6	60	4	36	2	25	2	67
Self-made drawings	10	100	11	100	4	100	3	100
Movies, TV	1	10	0	0	0	0	1	33
OHP, projector	1	10	2	18	1	25	1	33
Video recorder	0	0	1	9	2	50	0	0
Multi-media/computer	0	0	0	0	0	0	1	33
Laboratory Apparatus	8	80	6	55	3	75	3	100
Laboratory Chemicals/specimen	5	50	6	55	3	75	1	33

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PT 8 said,

> *"I used chalkboard, self-made drawing and cut out pictures due to their availability, high accessibility and convenience and I used charts because they are easy to handle and transport. And I got to maximize the time allotted for discussion. ".*

The respondents also added that they sparingly used laboratory and electronic apparatus (radio, movies and computers) because they are not fixed in the classrooms. The inconvenience of transporting and assembling them from one room to another is risky.

Methods Used in Teaching Science Subjects

The use of appropriate procedures or methods usually spells success in teaching-learning process. Lack of methodology therefore often leads to a decline in the level of knowledge-input among students. The new methods placed more emphasis on thinking and less upon memorizing, more on understanding and less on merely accumulating facts. Class activities are governed by democratic principles and ideas, group planning, selected materials, freedom from rigid regulation as well as control authority, and friendly attitude between teacher and pupil.

Table 3 shows that all science PTs used lecture and discussion, sometimes demonstration method in their on-campus teaching. They revealed that they felt inadequate to use the new methods and were afraid to try out new methods because they were not comfortable with it. They might not deliver their topic well and were afraid to get low grades in Practice Teaching. Demonstration was used by all Physics PTs. According to PT 21, demonstration and lecture method in teaching gives confidence in delivering the subject matter effectively to the whole class. The students can see the actual process of the experiment first before they asked to perform.

Only few teachers are using the inquiry approach, student theme project, and investigatory project methods. It can be noted that PTs concentrated on very few methods of teachings with which they are familiar and confident in delivering information to their students. Methods such as inquiry, problem solving, investigatory and discovery methods (Staver, 2007) were seldom utilized. These inquiry methods are child-centered since their principal aim is to the total growth and development of the child (Lardizabal, 2003). The inquiry method which promotes deep scientific understanding (Staver, 2007) and the problem solving are the first steps towards the development of critical thinking which sshould be a part of scientific knowledge.

Table 3. Methods Used by Pre-service Teachers in Teaching Science Subjects

Methods	Gen. Sci.		Bio. Sci.		Chemistry		Physics	
	f	%	f	%	f	%	f	%
Demonstration	9	90	7	55	3	75	3	100
Lecture and discussion	10	100	11	100	4	100	3	100
Student theme project	1	10	0	0	0	0	2	67
Role play with discussion	6	60	8	72	0	0	0	0
Individualized instruction	2	20	1	9	0	0	2	67
Student-directed activity	6	60	5	45	0	0	2	67
Teacher-directed activity	3	30	3	27	0	0	1	33
Concept-approach/mapping	2	20	4	36	0	0	2	67
Deductive/Inductive	3	30	1	9	0	0	2	67
Fieldtrip/community visit	1	10	2	18	1	25	1	33
Practical work approach	3	30	2	18	0	0	2	67
Concept-mapping	6	60	8	73	0	0	2	67
Problem-solving approach	6	60	4	36	2	50	1	33
Project evaluation	1	10	2	18	2	50	2	67
Open laboratory method	2	20	3	27	1	25	2	67
Structured laboratory	2	20	3	27	3	75	3	100
Cooperative learning	2	20	2	18	1	25	2	67
Inquiry approach	2	20	1	9	0	0	1	33
Investigatory project	2	20	1	9	1	25	1	33
Discovery method	6	60	2	18	1	25	2	67

P-ISSN 2350-7756 | E-ISSN 2350-8442 | www.apjmr.com

Table 4. Strategies Used by Pre-Service Teachers in Teaching Science Subjects

Strategies	Gen. Sci.		Biology		Chemistry		Physics	
	f	%	f	%	f	%	f	%
Feedback learning	3	30	4	36	1	25	1	33
Use of motivating questions/stories/trivia	9	90	10	91	1	25	3	100
Prepare wholesome atmosphere in the class	3	30	5	45	3	75	1	33
Use of live specimen	4	40	11	100	2	50	1	33
Use of models & charts	9	90	6	55	4	100	3	100
Storytelling	2	20	2	18	1	25	2	67
News reporting	2	20	1	9	1	25	1	33
Graded discussion	5	50	1	9	1	25	2	67
Conceptualization	2	20	5	45	0	0	2	67
Generalization	3	30	7	64	3	75	1	33
Role play, games	10	100	8	73	0	0	2	67
Values/topic integration	9	90	10	91	2	50	1	33
Multi-media effects	1	10	1	9	2	50	1	33
Topic reporting	3	30	3	27	0	0	0	0
Group discussion	9	90	11	100	3	75	3	100

Table 4 shows that all Physics PTs commonly used motivating questions, stories or trivia at the beginning of discussion. Attractive models and group discussion were also used as strategies in teaching. All Biology majors used live specimen with activity, while the Chemistry PTs usually used attractive models and the General Science PTs used simulation, role play, and games as their strategies in teaching. The Physics PTs used storytelling to provide information about the nature of science (McIntyre, 1996). This suggests that strategies used were varied in different science subjects. The multimedia effect in teaching however was only used by few of the respondents because they are not fixed in the classrooms and the equipment are not adequate.

Strategies are plans to meet certain situation to develop better service to learners (Boiser, 2000). According to Popil (2011) teaching strategies promote critical thinking and active learning. Clearly teaching is an art of employing strategies. Strategies in this study were described as practices that PTs usually do in teaching and those which allow them to rise above the casual and conventional approaches (Boiser, 2000). In Table 4, Topic reporting was used by few PTs since this is a conventional and boring approach according to the respondents. Topic reporting is boring since only one student is reporting in front of the class.

Table 5. Techniques Used by Pre-Service Teachers in Teaching Science Subjects

Techniques	**Gen. Sci.**		**Bio. Sci.**		**Chemistry**		**Physics**	
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Use of thought provoking Questions	7	70	10	91	3	75	3	100
Use direct eye contact and body expressions to elicit recitation	10	100	10	91	4	100	2	67
Use of rewards in graded recitation	10	100	11	100	4	100	3	100
Use of jokes and news to arouse discussion	7	70	9	73	4	100	3	100
Use of open textbook during discussion	5	50	3	27	1	25	1	33
Use of flashcards	5	50	4	36	0	0	0	0
Use of stick in teaching	3	30	1	9	1	25	0	0
Define objectives before the lesson	2	20	1	9	0	0	1	33
Use of hand-outs as supplement	5	50	4	36	2	50	1	33
Use of worksheets	1	10	3	27	2	50	2	67

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The technique used must be carefully selected and planned to fit the subject matter, the students and the objectives (Cioco,2003). Table 5 indicates that all Physics PTs employed the use of thought provoking questions, jokes, news, while the General Science PTs used of direct eye contact and body expressions as techniques and all PTs used rewards during recitation. The results of this study suggest similarities with the findings of Cioco (2003) that a teacher is an actor/actress who delivers powerful tools like eye contact, facial, hand and voice expressions. The teacher yields effective results by using direct eye contact with body, hand and voice expressions to convey their message to students.

Furthermore, according to the Biology PTs, the use of body expressions, jokes or trivia helped them make their discussion of subject matter more alive colorful and adds interest to the subject. Defining objectives before the lesson was least preferred by PTs Calachan (1998) however, found that the performance of the students in Science III is enhanced when exposed to the technique of defining objectives at the start of the lesson.

However, use of flash cards and defining objectives before the lesson was not commonly used by PTs because according to them use of flash cards is very elementary considering that their students are in high school. Defining objectives before the lesson elicit surprises among students thus, this method was used by few.

Pattern of Teaching as Described in their Lesson Plans

The 11 lesson plans in General Science illustrated this trend of teaching pattern: I. Objectives, II. Subject Matter, III. Activities, IV. Wrap-up, V. Evaluation, VI. Assignment. Part III of the plan was further divided into presentation of the lesson under which a) Recall, b) Motivation, and c) Development of the lesson were included. The activity was the longest part of the lesson and integration of values was part of motivation or sometimes in the wrap-up.

The 19 lesson plans in Biology have three major parts, namely: I. Objectives, II. Subject Matter and III. Learning Tasks. The learning tasks were further subdivided into a) Pre-Developmental Activity, b) Lesson Proper, c) Wrap-up/Synthesis, d) Evaluation, and e) Assignment and Enrichment. The Pre-developmental Activity was divided into two parts, namely: 1) Recall and 2) Motivation which was often a game, role play or an activity. The learning task was the longest part of their lesson plan. Values integration was a part of wrap-up or learning task to discuss nature and environment.

The 16 lesson plans in Chemistry involved the pattern: I. Objectives; II. Subject Matter; III. Learning Tasks, which is subdivided into a) Recall, b) Motivation and c) Discussion; IV. Generalization; V. Valuing; VI. Evaluation and VII. Assignment. The Chemistry PTs used generalization or application of theories instead of synthesizing the whole lesson, and application of the lesson to daily life was included in valuing. Values integration was a part of application of theories in the lesson plan. In two cases of class observations values integration was at the end of the lesson.

The Physics PTs have a common pattern of teaching: I. Objectives, II. Subject Matter, III. Learning Tasks; IV. Assessment and V. Assignment. The Learning Tasks have several parts, a) Motivation, b) Lesson Proper, whereby discussion and problem solving was used, c) Generalization and d) Application. The generalization was followed by applications to problem set. The values integration was a part of the lesson plan but observations showed that there was no integration in the actual discussion.

CONCLUSIONS AND RECOMMENDATIONS

The PSU science Pre-service Teachers commonly used books, instructors' handouts from classroom lectures. They often used chalkboard, cut outs, pictures and self-made drawings as teaching materials. They seldom used electronic devices as teaching aids. Their teaching methods include lecture with discussion and demonstration. Methods that develop scientific inquiry among high school students such as problem-solving, discovery and inquiry approach were seldom used. The common strategies employed by PTs in science were the use of interesting questions, stories or trivia particularly at the beginning of the lesson. In particular the General Science, Chemistry and Physics PTs used attractive pictures and models, while the Biology PTs used live specimen to facilitate learning. For better class discussion the PTs employed techniques such as the use of thought-provoking questions, jokes, as well as news, direct eye contact, body expressions, and reward.

The general pattern of the lesson plans in Science teaching is as follows: I. Framing of Objectives, II. Stating the Subject Matter, III. Planning of the Learning Tasks, IV. Synthesis/Wrap-Up of the Lesson, V. Evaluation/Assessment and VI. Assignment/Enrichment. Use of activities or games before discussion motivated the students.

P-ISSN 2350-7756 | E-ISSN 2350-8442 | www.apjmr.com

Generalization after the discussion and valuing were also inherent pattern in the lesson plans. It was also a practice among PTs to give a written quiz after a lesson.

The Pangasinan State University science pre-service training has less flexibility, innovations and creativity in the methods of teaching but are rich in artistic instructional materials and techniques. The science PTs' have minimal training on the use of scientific inquiry, investigation and problem solving where the high school students are trained to think independently for lifelong applications of theories. It is then suggested that the PSU College of Teacher Education should conduct more trainings, peer teachings, seminars and workshops to try strategies that promotes critical thinking and challenge the pre-service teachers' creativity. The College should provide modern instructional materials and equipment to level up their strategies and techniques proven to be good through research. The PTs should learn to apply research results in teaching in order to test theories, and at the same time use sensory interactive activities in science.

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P-ISSN 2350-7756 | E-ISSN 2350-8442 | www.apjmr.com