VALIDATION AND FIELD TRY-OUT OF THE PROGRAMMED INSTRUCTION IN CHEMISTRY FOR SECONDARY STUDENTS

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Abstract

Programmed instruction in Chemistry was produced. The instrument used was patterned after of the work of Ticao (1986). It was face validated by jurors whilst the content and construct was validated by the teachers. Factor Analysis proved the validity of the evaluation of the programmed instruction in five Learning areas, namely: (a) Physical aspects (b) Objectives (c) Instructions, (d) Learning activities, and (e) Evaluative measures. The programmed instruction was evaluated as excellent and highly acceptable. It was tried out to one intact group of junior high school students. Results showed a fair to very satisfactory pre-and posttest scores in chemistry. Results also showed a significant difference in the pre- and post-test scores of the students. In conclusion, Programmed instruction improved junior students' performance in Chemistry.

Keywords: Programmed instruction; Chemistry; Factor analysis; Learning areas

Introduction

Redesigning physical science Chemistry education so as to 21st century requirements must include not only what is taught, but also the way it is taught. It is a common observation that in physical science where the students' lessons are highly abstract where the students are only in their concrete developmental stage. Programmed instruction, as a teaching medium, afforded students the opportunity to work at their own speed. Since the learners were not forced to work at the same pace they in effect were receiving individualized instruction. Ediger and Rao (2005) alluded that science education has become an integral part of school education. So the quality of science teaching is to be developed considerably so as to achieve its purposes and objective, this is to understand basic principles, to develop problem solving, analytical skills and ability to apply them to the problems of material environments and social living besides promoting the spirit of inquiry and experimentation. In this modern world dominated by Science and Technology, science teaching must be effective, innovative, and beneficial to the learners. Clark (1996) further explains that physical sciences education must be designed appropriately to the needs of the learners in order to develop them intellectually and morally to participate fully in a technological society as, informed citizen, pursue further studies in Science and Technology, and enter the world of work.

Programmed instruction involves the use of programmed lessons. It is a simple means for presenting the learning activities in sequences—in small-step, constructed-response program. In the programmed instruction, the fact that the instructional objectives aligned with the subject matter was atomized into tiny bits and presented to students via sufficient number of easily understood statements guaranteed correct responses in most instances. Instructional objectives in science, according to Palma (1992), includes: (a) knowing, (b) comprehending, and (c) calculating. Students learn by doing; and when one knows more about children, the best can be expected of them. More opportunities should be provided to develop the children to become useful and productive citizens in the society in which they live. Students' physical science Chemistry learning and retention can be enhanced by supplementing teachers' instruction in a physical science methods course self-instruction thru process skills on a programmed instruction. The Chemistry students' are helped by the teacher to gain skills and mastery in physical science processes and skills in order to attain and use Chemistry knowledge in a meaningful way, learn the concept through a planned teaching sequence – that of simpler tasks learned as prerequisite to a major task and experience a highly structured and sequenced learning through a worthy guided learning of a constructed learning hierarchy, hence, this study.

Background

This study, which was concluded in February 2009, had attempted to determine the validity of the participants' evaluation of the programmed instruction in Chemistry for secondary students (Phase I) and II the try-out of the validated and reliability tested material for dissemination and diffusion stages. During Phase I, the material, which was in the form of programmed instruction, was developed by the researcher following three stages including--design, production, and the evaluation. The programmed unit instruction for its try-out model "Gas Laws". It includes topic on the four laws under the ideal gases, namely: the Boyle's, the Charles', the Gay-Lussac's and the Combined Gas. Sixteen numbered frames of programmed instruction in Chemistry for secondary students were produced. These were submitted to 30 teachers who evaluated the acceptability of the material as a whole and in terms of the following: (a) physical aspects, (b) objectives, (c) instruction, (d) learning activities, and (e) evaluative measures.

This investigation attempted to determine the validation and field try-out of the programmed instruction in Chemistry for secondary students. The quantitative-descriptive experimental research was employed in the study. Most experiments in education employ some form of the one-variable design. One-variable experiment involves the manipulation of a simple treatment variable followed by observing the effects of this manipulation on one or more dependent variables. The variable to be manipulated is referred to as the experimental treatment. It is also called the independent variable, experimental variable, treatment variable, or intervention. The variable that is measured to determine the effect of experimental treatment usually is referred to or the posttest, dependent variable, or criterion variable. In this study, the term posttest is used to describe the measure of the variable that is the intended outcome of the experimental treatment. If a variable is measured before administering the experimental treatment, this measure is called a pretest. In this experimental study, one intact group receives the experimental treatment by the use of a validated research material called the programmed instruction in Chemistry for secondary students.

This study involved two phases: Phase I, the validation of the programmed instruction as research material and Phase II, the field try-out of the validated research material. The Phase I of the study: the validation of the programmed instruction in Chemistry for secondary students. The entire study aimed to determine the acceptability and validity of the programmed instruction for secondary students. The research material was validated by 30 teachers on the following five learning areas: (a) physical aspects, (b) objectives, (c) instructions, (d) learning areas, and (e) evaluative measures.

The teachers were teaching Chemistry as subject in the third year curriculum. The instrument used to validate the research material was a survey-questionnaire patterned after that of Ticao (1986). The factor analysis via varimax rotation was the statistical tool used in the validation of the research material. The data gathered were tabulated, analyzed, and interpreted quantitatively. The descriptive statistics were subjected to certain computer processed statistics. Specific problem 1 aimed to determine the acceptability and validity of the programmed instruction as evaluated by thirty teachers in general, and in terms of: (a) physical aspects, (b) objectives, (c) instructions, (d) learning activities, and (e) evaluative measures using a survey questionnaire patterned after that of Ticao (1986). Phase II of the study was the field try-out of the research material. The one group quasi-experimental pre-test and post-test design was employed. This design is one of the widespread designs used in educational research in which the experimental group is an intact group, a group that constitutes a naturally assembled collection, such as a classroom. The research design is diagrammed as shown in Figure 1.

O_1 X O_2

where:

O_1 = Pretest scores
O_2 = Posttest scores

X = treatment

Figure 1. The Research Design.

Review of Related Literature

Results of the Third International Mathematics and Science Study (TIMSS) showed the poor performance of the Filipino students (almost at the bottom of the ranking) in the cross-country evaluation. This should be good enough reason to consider any curricular innovations. TIMSS results reflected the poor state of science instruction in the country. As a consequence, the factors that contributed to the very poor performance of the Filipino learners were looked into in preparation for curricular revisions aimed at elevating the degree of competency of science educators in the Philippines (Bago, 2001). The most crucial question is, what are the possible factors that influence students' achievement in Chemistry? The investigator has been teaching Science and Technology III (Chemistry) for twenty eight years in the public school secondary level. One alternative thought of producing a science instructional material is the use of a strategy called programmed instruction (Arce, 2002). Programmed instruction could be an alternative teaching technique that would respond to the needs and nature of Chemistry learners. Pelaez (2005) alludes that traditional teaching methods have worked for years; it would not hurt to incorporate new ideas or strategy in the teaching of science to improve results on students' achievement.

Every child can learn and it is the responsibility of science educators to adapt proper strategies to students' particular ways of learning. Today teachers must be able to use instructional material/strategy that will capitalize on a student talent and further develop his or her intelligence. Vygotsky (1978) recognized the importance of programmed instruction in cognitive development. Exposure and immersion of programmed instruction as a strategy in the teaching of a subject is explored in this study. The social world (teacher or peers, instructional material, and teaching strategy) are the sources of the learners science concepts, ideas, facts, and skills. Cognitive development is a socially-mediated process, which takes place optimally when learners interact with the teacher method of teaching. The validation and field try-out of programmed instruction in Chemistry for secondary students using the Stufflebeam CIPP model as shown in Figure 2.

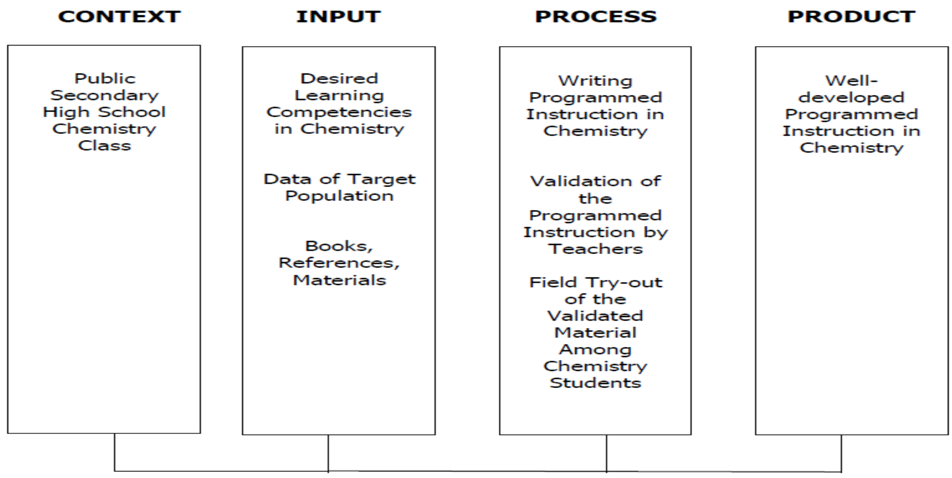

Figure 2. Validation and field try-out of the programmed unit instruction in chemistry for secondary students' using the Stufflebeam (CIPP) model (Bago, 2001).

The model illustrates the relationship of the three processes in the development of programmed instruction as an instructional material in Chemistry. The input namely: the curriculum instructional guide, the process-oriented tasks, the target population, and the books and other reference materials will provide basis and scaffold for the making of the programmed instruction. In the process of writing lessons for programmed instruction in Chemistry, the researcher was guided by different pedagogical and scientific principles. It took into account the assumption that chemistry teachers are equipped with high order thinking skills like problem-solving, creative and critical thinking, and decision making, so they can pass on these skills to their students, for the latter to use in coping with the changes in physical science subjects as well as their socio-cultural environment. With programmed instruction, it is hoped that the product which could be well-developed curriculum material on the teaching of Science and Technology III (Chemistry) be promoted among secondary students and teachers as well.

In the programmed instruction, the emphasis is placed upon changing students rather than the subject-matter and the students are the focus instead of the teacher. Since the Chemistry basic lessons are highly abstract, students needed to learn content matter by gradation. It is a belief that by learning subject-matter incrementally, students would gain mastery of simple concepts before advancing to more challenging and complex one. Thus, careful sequencing of information shaped or gradually leads students toward the desired goal, by rewarding them for activities that are closely approximated to those goals. In fact, in Ogunniyi (1995), it is spelled out in the curriculum that, "At the end of basic physical science education, the students would have developed the ability to use Chemistry process, skills, and techniques to carry out systematic inquiry in an effort to prepare him for adulthood in a rapidly changing world". Further, this material requires students to produce output that will demonstrate their ability to use analytical, critical, and creative thinking skills. Thus, the scope and sequence of the subject matter to support cumulative learning expected in the discipline. Developing programmed instruction and other instructional materials using the new teaching approaches are required by the Bureau of Education (BEC).

The successful completion of the programmed unit instruction by the students shows the understanding of concrete concepts on this material. Since the students' behaviors are recorded on each frame, knowledge of their understanding of the lesson is easily obtained. Learning behaviors had to take place under the right condition. Ideally, Chemistry processes should be given considerable emphasis in preparing and planning out the lessons so that the students will gain a functional understanding of the processes by which physical science concepts and principles linked with natural phenomena are generated by the scientists. Furthermore, acquiring and practicing Chemistry processed skills fitted to the lessons prepares students to become more logical in their way of thinking and more analytical in the way they approach a problem. Thus, instructional techniques are crucial in physical science lessons, and it should be given importance in students' learning.

The process of Chemistry teaching should be knowledge (content) and skills/processes. Wade (1994) recommends that physical science process skills instruction should be included in the programmed instruction through the use of a scientific thinking skills method course. Hamil (1994) has established a significance that the process skills instruction should be included in the programmed material through the use of process skills unit in a control area or in a process skills method course, and that physical science education should consider the possibility that formal reasoning ability and highly abstract process skills in Chemistry may be indistinguishable competencies. In the programmed instruction, the pre-set scores for mastery, according to the observations of Bloom (as cited in Querubin, 1997), Acero et al. (2000) and Ediger and Rao (2005), was that 75 percent of the students can learn all that the school has to teach at a mastery level. In this study, the criterion for mastery was set at 80% correct of the total items. Thus, 100% of the students are expected to obtain a score four out of five items to be allowed to go to the next frame of the programmed instruction. A student who fails to attain a score for the mastery level is required to read the instrument as many times needed for a better chance to attain mastery, after which, the same posttest is given or administered. This should be accomplished before the start of the next regular session in Chemistry. According to Ediger and Rao (2005), B. F. Skinner was very instrumental in emphasizing the S-R theory of instruction. With the S-R theory in teaching science, Skinner advocated programmed learning for learners. Programmed learning can take place in an instructional material or as a teaching strategy. This study was likewise promised on that advocacy. Furthermore, science education has an integral part of the school curriculum. Science teaching would focus on the most basic principles for students to comprehend, think analytically, and be able to solve problems in a real life situation. Since chemistry lessons are highly abstract, the teaching of science must be on student's nature, readiness, and mental capacity.

Programmed instruction as a teaching medium is self-instructional. It is a self-evaluating. In effect, students learned at their own pace that will lead them to a desired goal. Science education change students' behavior through their acquired science thinking processes in their science classroom. Programmed instruction is in a form of learning frames followed by a test. The scores would be at least 75% correct to attain mastery and in order to qualify to proceed to the next frame. If the students are wrong, they will be help by the teachers to gain skills and mastery in their lessons. The use of programmed instruction as a curriculum material in teaching and learning include both foreign and local studies. Different studies showed that programmed instruction improved significantly not only to the students' scores but also their positive attitude towards the subject. The learning activities in the programmed instruction should be plan and is written in small bits. It is designed to teach students individually to allow them to move at their own pace. Thus, a student centered education.

The science curriculum is spiral, the learning activities are aligned with the learning objectives that is written in hierarchy. So the learning activities are learned from unit to unit and to the entire programmed instruction rather than repetitive. This programmed instructional material/technique also motivates the learning of the students and improve their thinking skills on problem solving technique. Scores differ significantly among students. Studies showed that programmed instruction significantly affected students reasoning, problem solving, and application ability. Programmed instruction possesses modularity theory that relates to individual development. Module makes up a programmed which are based in one subject area and presented in linear sequence. It induced learning with minimum teacher direction. The present programmed instruction presented in spiral pattern. In essence, its learning activities simultaneously building up each other from unit to unit and as a whole.

Work plan for programmed instruction includes the problem of lack of instructional material in Chemistry; programmed instruction was prepared to answer the need and is as follows: (1) To consider individual differences; (2) To lower the cost of education; (3) Step-by-step-principle; (4) Immediate verification; (5) Learning progresses logically; and (6)The principle of individual pace. The roles of programmed instruction are the following met by the material: (1) all elements are brought together by time and space; (2) individual differences are catered to and the objectives are achieved; (3) statements of objectives; (4) information sequenced in logical steps-then testing; (5) utilized unlimited scope for a variety of methods; (6) bring students participation into one learning sequence; and (7) immediate feedback on students' progress. The following are steps on writing programmed material: (1) The objectives of the program are established; (2) The post-test is prepared; (3) writing the post-test; and (4) activity unit is prepared consisting of frames.

Programmed instruction methods are as follows: (1) Programming itself is the writing of sequential steps structured so as to bring about a learning experience; (2) Programmed materials are self-instructional; (3) This type of instruction is highly individualized; (4) It requires the so called criterion-referenced type of evaluation and not the norm-referenced type; (5) It requires the teacher to play three distinct rules in today's school-director, analyst, tutor; (6) It is not a complete instruction by itself; and (7) programmed instruction requires a lot of materials.

A programmed instruction to be complete must contain the following components: (1) Title; (2) Target population; (3) Overview; (4) Objectives; (5) Instructions to the learners; (6) Entry behaviors and prerequisite skills; (7) Pre-test; (8) Pre-test feedback and evaluation;(9) Learning activities; (10) Post-test; and (11) Teacher's manual or guide. The basic characteristics of programmed instruction are the following: (1) The programmed instruction is self-contained; (2) The programmed instruction is typically individualized; (3) Programmed instruction is a complete package; (4) The programmed instruction includes learning experiences and objectives; and (5) The programmed instruction is a mechanism for assessing the extent to which the students has achieved programmed instruction objectives.

Principles and styles of writing programmed instruction are as follows: (1) Make the learning programmed instruction readable; (2) Use pronouns "YOU" and "I"; (3) Choose the right word not phrases; (4) Remember to write plainly and simply; (5) Use a light touch; (6) It is also to use human when deemed appropriate; and (7) lastly, be reader friendly. Computer-assisted instruction studies showed that programmed instruction was the most effective than computer assisted instruction and teacher recitation/discussion such as: (1) In promoting higher order thinking skills such as problem solving as well as forming positive attitude toward students; (2) substantial savings in instructional time; (3) Best teaching strategy in formula writing and balancing chemical equations; (4) programmed instruction more active instructional tool than computer assisted instruction; (5) It explicitly teaches problem solving as it is relatively distraction-free; (6) students like the programmed instruction better than traditional recitation/discussion method; (7) Programmed instruction students perform better which caused to learn better attitude toward the instructional design; (8) programmed instruction teaches students problem solving strategies, whereas teachers assistant show problem solving strategies, but do not teach these strategies.

Statement of the Problem and Hypotheses

The validation of the programmed instruction as a research material was referred to as Phase 1 of the study. In this phase, the acceptability and validity of the programmed instruction through the evaluation among teachers was established through quantitative-descriptive method.

The question asked in Phase I was: "What is the acceptability and validity of a programmed instruction in Science and Technology III (Chemistry) produced in general and in terms of: (a) Physical aspects (b) Objectives (c) Instructions (d) Learning activities and (e) Evaluative measures among the participants?" Phase II of the study involved the field try-out of the material to the Chemistry students employing a one-group quasi-experimental pre-and post-test design (Borg & Gall, 1989). The experimental group was a regular class consisting of one intact group/section of 55 students scheduled 7 to 8 a.m. in the morning from Monday to Saturday (as required) and at 9 a.m. to 10a.m. every Tuesday. This intact group of students was taught by the teacher recommended by the school administrator as demonstrator teacher. The experimental students belonged to the Star Section III of Passi National High School, Passi City, Iloilo during the third grading period for school year 2007-2008. The lesson plans, the programmed instruction, and the 55-item pre- test and post- test instruments were prepared by the researcher.

The study in Phase II sought answers to the following questions:

1. What is the level of the pretest scores in Chemistry as revealed by the experimental participants?
2. What is the level of the posttest scores in Chemistry as revealed by the experimental participants?
3. Is there a significant difference in the pretest and posttest scores in chemistry of the experimental participants?

The following hypothesis was tested:

There is no significant difference in the pre-test and post-test scores in Chemistry of the experimental participants.

Method

This study involved two phases. The Phase I was the validation of the research material, and Phase II was the field try-out of the validated research material as shown in Table 1.

Table 1
The Methodology Used in the Study

Methodology	
Phase I	Phase I
Participants	Participants
The Material	The Material
Source of Data and Data-gathering Procedure	Source of Data and Data-gathering Procedure
Statistical Data Analysis Procedure	Statistical Data Analysis Procedure

Part I: The Validation of Research Material

Participants. The participants who evaluated the research material of the study were the 30 Chemistry teachers teaching Science and Technology III (Chemistry) in the different schools in Division of Iloilo, Iloilo City, school year 2007-2008.

The material. This section describes the research material development using a standard pattern (Ediger & Rao, 2005) in the University of the Philippine-Diliman. For Phase I of this study, the researcher prepared the programmed instruction as research material in a certain unit in Science and Technology III (Chemistry) for secondary students. The preparation of the research material involved three major stages: design, production, and evaluation.

1.1 Design stage. The researcher proposed a working plan for the research material considering the target population. The respondents were the Star Section III students of Passi National High School, Passi City, Iloilo last January 21 to February 2, 2008 for a ten-day experimental study during school year 2007-2008. A particular unit of work was selected. The learning tasks were broken down into smaller specific tasks and were sequenced. The research material was written in bi-spiral pattern following Bloom's Taxonomy (Alford, Herbert & Frangenheim, 2006) of Instructional Objectives.

1.2 Production stage. In the plan of work, the researcher proceeded to the actual writing of the materials. This was the lengthy part in the development of the research material.

The following were the components of the research material prepared:

- The *preface* introduces the research material to the students providing information on importance of the programmed instruction as instructional material/strategy in teaching.
- The *entry level* serves as the preparation of the target population. Their nature, capabilities, readiness in handling the lessons, were considered as prerequisite skills needed by the present unit.
- *General instruction was* a guide to the students' on how they would go about the learning activity.

- Programmed instruction *objectives* serve as a guide for the students. These indicate the necessary skills to be developed at the completion of each lesson. The objectives are categorized into cognitive, affective, and psychomotor skills.
- The programmed instruction *guide* gives a brief outline of the lessons covering "Gas Laws" model indicating what topics were discussed/included.
- The *text* was the instructional part of the lessons. It was presented as odd numbered frames of the programmed instruction. It include learning activities that contained the items the students expected to know and understand the information stated in the lessons that came from various authors who were expert in the field.
- The *quiz/progress* check was presented as even numbered frame each odd numbered frame in the research material. It determines how the student understood the lessons discussed in the research material. In case student got below the cut-off scores, assessments and optional exercises were done.

The schematic diagram of programmed instruction covering "Gas Laws" is shown in Table 2.

Table 2
The Programmed Instruction Structure

Step	Programmed Instruction
1	Title: Gas Laws
2	Preface
3	Entry Level
4	General Instruction
5	Outline of the Unit/Guide
6	Pre-test
7	Start in Frame 1 (New Lesson): Odd Frame
8a	Even Frame. Quiz or Progress Check
8b	For Feedback Answer Check: Answer Key for the Even Frames
8c	Repeat 8a, b, 8c
9	Post-test for Programmed Instruction

1.3 Evaluation stage. The prepared programmed instruction covering "Gas laws" as research material underwent evaluation. Face validity was done by the jurors, content and construct validity, by thirty Chemistry teachers, and fielded for try-out to Chemistry students.

Validation and Reliability of the Research Material

Sources of data. For Phase I, the data needed were obtained through the use of the Survey Questionnaire. The research material was rated by 30 teachers teaching chemistry using the five point Likert scale patterned that of Ticao (1986). The participants used the survey-questionnaire that contains five Learning areas: (a) Physical aspects (b) Objectives (c) Instructions (d) Learning areas and (d) Evaluative measures. The indicators used are presented in five columns: column 1, excellent (5); column 2, very satisfactory (4); column 3, satisfactory (3); column 4, fair (2); and column 5, poor (1).

The following scale of means and corresponding descriptions were employed:

Scale	**Description**
4.21– 5.00	*Excellent*. All aspects of instruction and work are very adequately covered and the quality of work is superior

3.41 – 4.20 *Very Satisfactory.* The major aspects of instruction or work are covered with above average standard.
2.61 – 3.40 *Satisfactory.* The major aspects of instruction or work are covered with minimum acceptability.
1.81 – 2.60 *Fair*. The major aspects of instruction or work are covered with minimum acceptability.
1.0 – 1.80 *Poor*. The major aspects of instruction or work are very In-adequately covered.

A rating of Excellent (4.21 to 5.00) indicated high acceptability; while a rating of Very Satisfactory (3.41 to 4.20) indicated acceptability; whereas, a rating of Satisfactory (3.40 to 2.61 and below) indicated unacceptability. The research material was refined after the suggestions of eight jurors- expert in Chemistry teaching and was thereafter printed in its final form.

Validity of research material. Part I was the validation of the research material. The ratings given by the 30 teachers in the research material in general and on the five Learning areas, namely: (a) Physical aspects (b) Objectives (c) Instructions (d) Learning activities and (e) Evaluative measures were computed using Factor Analysis via the Varimax rotation.

Factor analysis results revealed factor loads ranging from .609 to .923. According to Alicias (1985, in ; in Abioda, 2009), there is no hard-and-fast rule for factor loading, except that, which is arbitrary determined by the researcher. However, a factor loading of +.50 or higher is commonly used. Following Alicias, the researcher employed the +.50 or higher criterion for the acceptance or rejection of the items included in the research material. Hence, all the items evaluated were valid factors for their respective administration.

Reliability of the research material. The final draft of the research material was submitted to the resource persons. After they have confirmed the validity of the programmed instructional material, it was fielded for try-out in part II of the study.

Data-gathering procedure. After the approval of the research instruments, permission to conduct the study was secured from the Regional director, the Schools Division Superintendent, and the Principals of the schools where the data-gathering materials were administered. The research material was evaluated by thirty Chemistry teachers. Data were coded, tallied, tabulated, and subjected to appropriate statistics.

Data Analysis Procedure

The following were used in the analysis of the obtained data for Phase I.

- ***Frequency***. The frequency was used to determine the ratings of the research material given by thirty teachers.
- ***Mean.*** The mean was used to describe the ratings the teachers gave on the research material based on the following statements on the five Learning areas, namely: (a) Physical aspects (b) Objectives (c) Instructions (d) Learning activities and (e) Evaluative measures.
- ***Varimax rotation***. The factor analysis via varimax rotation of the SPSS was used to determine the validity of the participants' evaluation of the research material in five

Learning areas, namely: (a) Physical aspects (b) Objectives (c) Instructions (d) Learning activities and (e) Evaluative measures.

Part II – The Field Try-out of the Research Material

Phase II of the study involved the field try-out of the validated research material. The mechanics and research method used are explained in this section.

Participants

The participants of the study comprised one intact group of 50 students and handled by their chemistry teacher as a demonstrator teacher of the experimental participants.

Sources of Data

Chemistry pre-test and post-test instruments. A Chemistry performance test for the experimental group was constructed based on the chemistry concepts, facts, and principles as well as from teaching experiences and observations. The researcher followed Bloom's Taxonomy (Alford et al., 2006) in measuring students' skills, which include knowledge, comprehension, application, analysis and synthesis using a 2x2 contingency table of specification. The 55-item test was subjected to reliability test via the Cronbach alpha. The obtained reliability coefficient was .9678. This indicates that all of the items included in the test were highly reliable. The test was also subjected to Spearman Brown's split-half reliability test and had an obtained reliability coefficients of .9518.

Interpretation of the Students' Scores in the Pretest and Posttest

To determine the experimental participants obtained pretest and posttest scores, the researcher used the scale as follows:

Scores in Pre-test and Post-test	Interpretation
46-55	Very Good
38-45	Good
28-37	Fair
28 and below	Poor

Data-Gathering Procedure

The steps employed by the researcher in conducting the experiment were as follows:

1. The researcher sought permission of the dean of the Graduate School, West Visayas State University, to conduct the experiment;
2. The school administrator approved for the conduct of the study utilizing one intact group taken as participants and were handled by their chemistry teacher;
3. The group was exposed to the following: Subject-matter. The topic in Unit "Gas Laws" was a programmed instruction as teaching material/strategy adopted by the demonstrator teacher for ten consecutive days;
4. From the experimental participants a random sampling was used to select 50 subjects;
5. The intervention used by the researcher, namely: the programmed instruction;
6. During the trial by a group of students, the teacher closely observed the students and they were instructed to: (a) complete the pretest and return it immediately to the researcher by their demonstrator-teacher in a sealed envelope. The researcher submitted the envelop to the checker chosen by the dissertation committee

immediately on that day; (b) work through the programmed instruction at their own pace, understanding all activities and answering questions; (c) indicate the time at which they state and finished at their work at the record sheet provided for each lessons; and (d) make notes on a record sheet about the lessons they learned and any aspect which was difficult to understand or which seemed to take them much time or problem, the style, the wording, and so on.

After all the students completed this work, they undertook the following: (a) answered the questions on the project quiz noted any difficulties on a data sheet, and returned the completed daily quiz to the teacher and; (b) discussed all the items they had listed on the data collection record sheets and from points that would emerge from the discussion; (7) The researcher administered a posttest and placed the answer sheets in the enveloped sealed by their teacher and given back to the researcher. The researcher immediately submitted it to the checker for checking. Statistical Data Analysis and Interpretation of results were done. The scores in the pretest and posttest were computed and compared, using the t-test for independent samples. The formulated null hypothesis was answered.

Statistical Data Analyses Procedure

The data gathered for Phase II were subjected to certain computer-processed statistics: (1) Frequency. This was used to determine the experimental participants' pre-and post-tests scores in chemistry; (2) Mean. This was used to describe the pretest and posttest results of the experimental participants; (3**)** Standard deviation. This was used to determine the dispersion of scores from the mean, to determine the students' homogeneity or heterogeneity; (4) Cronbach alpha. This was used to determine the reliability of the 55-item pretest and posttest instruments in Chemistry; (5) t-test for independent or paired samples. This was used to ascertain the significance of the difference between the pretest and posttest scores of the two independent samples. The significance was set at .05 alpha levels. All the interpretations were based at .05 alpha level of significance using two-tailed tests. All statistical computations were availed of via Statistical package for the Social Science (SPSS) software.

Results

Descriptive Data Analyses

Phase I of the study initially attempted to determine the teacher participants' acceptability and validity of the programmed instruction in chemistry for secondary students in general, and in terms of five Learning areas, namely: (a) Physical aspects (b) Objectives (c) Instruction (d) Learning activities and (e) Evaluative measures. Mean and factor analysis via varimax rotation were employed in the study.

Participants' Validation of the Programmed Instruction in Chemistry for Secondary Students

Analyses of the data of the programmed instruction were as follows:

- *Physical aspects*, the programmed instruction received a rating of 4.10, or "Very Satisfactory", indicating that the participants actually found the lay-out of the material clear and the learning package handy.
- The items on *Objectives* obtained a rating of 4.23, or "Excellent". This showed that the participants considered the objectives achievable throughout the content. The objectives were found to be stated in behavioral terms with

outcomes objectively observable. The objectives as perceived to most likely develop the students' skills in Chemistry.

- *Instruction*, had a rating of 4.34, or "Excellent". The subject-matter was considered relevant to the course content. Found suitable to the target learners, the learning activities were believed to be able to carry out the objectives of the programmed instruction. They were likewise found adequate, varied and properly sequenced with provision for individual and group participation. Optional exercises were also made for immediate feedback. The participants found that the activities could be carried out with ease and speed. The entire learning package was found to have adequate coverage of content pertinent to the course.
- *Evaluative measures* as viewed by the participants were rated 4.323, or "Excellent". The pretest and posttest items were found appropriate in so far as they measured the skills they were intended to measure. These items were also who perceived to be parallel to the work done in class and the lessons for the specific topics were adequately represented.

As a *whole*, the programmed instruction in chemistry for secondary students was rated 4.365, or "Excellent", which means that all aspects of the work or instruction have been adequately covered and the quality of the work was superior. Results of participants' rating on the five learning areas of programmed instruction in Chemistry for secondary students are shown in Table 3.

Table 3
Teachers' Evaluation of the Programmed Instruction in Chemistry for Secondary Students

Learning Areas	Mean	Description
A. Physical Aspects.		
1. The lay-out of the material is clear.	3.97	Very Satisfactory
2. The whole material is handy.	4.23	Excellent
Average Score	4.10	Very Satisfactory
B. Objectives		
1. The objectives are stated in behavioral terms.	4.13	Very Satisfactory
2. The objectives are achievable through the content written in sequential frames.	4.40	Excellent
3. The objectives are will develop higher-order thinking skills and science processes in chemistry.	4.17	Very Satisfactory
Average Score	4.23	Excellent
C. Instruction		
1. The instruction is clearly worded.	4.40	Excellent
2. The instruction is clear.	4.27	Excellent
Average Score	4.34	Excellent
D. Learning Activities		
1. The subject-matter is relevant to the curricular content of Science and Technology III (Chemistry).	4.53	Excellent
2. The learning activities are suited to the target learners.	4.40	Excellent
3. The learning activities carry out the objectives of the instructional material.	4.33	Excellent
4. The context of the material are properly sequenced from simple to complex learning tasks.	4.37	Excellent
5. The learning activities can be executed with relative ease	4.13	Excellent

and speed.		
6. Immediate formative tests are provided.	4.37	Excellent
7. The learning activities of the entire unit adequately cover the Content pertinent to the course.	4.10	Excellent
8. Summative evaluations for the unit is provided.	4.40	Excellent
9. Within the entire unit, the chemistry concepts are presented in frames.	4.23	Excellent
10. The concepts learned in each frame are prerequisites to the next frame.	4.37	Excellent
Average Score	4.32	Excellent
E. Evaluative Measures		
1. The summative test items measures the skills it intend to measure.	4.40	Excellent
2. Items of the summative test adequately cover the chemistry concepts, facts, and principles for secondary students.	4.33	Excellent
Average Score	4.37	Excellent
Average Rating of Instructional Material	4.37	Excellent

The individual scores obtained a rating of Excellent (4.21 to 5.00), indicating high acceptability; while a rating of Very Satisfactory (3.41 to 4.20) indicated acceptability; whereas, a rating of Satisfactory (3.40 to 2.61 and below) indicated unacceptability. Thus, the programmed instruction as a whole, the items evaluated by the teachers were generally highly acceptable.

The participants validity in evaluation of the programmed instruction in general and in the five Learning areas, namely: (a) Physical aspects (Items 1 & 2) (b) Objectives (Items 3, 4, & 5) (c) Instructions (Items 6 & 7) (d) Learning activities (Items 8, 9, 10, 11, 12, 13, 14, 15, 16, & 17) and (e) Evaluative measures (Items 18 & 19) were considered. These individual scores obtained were subjected to Factor analysis via the varimax rotation. Factor analysis results revealed factor loads ranging from .609 to .923. There is no hard-and-fast rule for factor loading, except that, which is arbitrarily determined by the researcher. However, a factor loading of +.50 or higher is commonly used. The researcher employed the +.50 or higher criterion for the acceptance or rejection of the items included in the research material. Hence, all the items evaluated were valid factors for their respective administration. Results of the factor analysis are shown in Table 4.

Table 4
Factor Analysis Results for the Participants Validity on Evaluation of the Programmed Unit Instruction in Chemistry

Item	Factor Load	Decision
1	.648	Retain
2	.888	Retain
3	.638	Retain
4	.923	Retain
5	.732	Retain
6	.646	Retain
7	.710	Retain
8	.687	Retain
9	.788	Retain

10	.699	Retain
11	.719	Retain
12	.698	Retain
13	.615	Retain
14	.671	Retain
15	.802	Retain
16	.712	Retain
17	.609	Retain
18	.915	Retain
19	.722	Retain

Phase II of the study initially attempted to determine the participants' pretest and posttest scores in the subject. Mean and standard deviation were employed for the purpose.

Participants' Pre-test and Post-test Scores in Chemistry

Data in Table 5 reveal that the experimental students' Chemistry scores shifted from "Fair" (M = 29.16) in the pretest to "Very Good" (M = 49.74) in the posttest.

Table 5

Experimental Participants' Pretest and Posttest Scores in Chemistry

Intervention	Experimental Group		
	M	Description	SD
Pretest	29.16	Fair	6.31
Posttest	49.74	Very Good	2.51

The obtained SDs ranging from 2.51 to 6.31 showed the narrow dispersion of the scores under each category, reflecting the homogeneity of the students in relation to their pretest and posttest scores in chemistry.

Inferential Data Analysis

Data in Table 6 show that a significant difference existed between the pretest and posttest scores in Chemistry among the participants in the experimental group, $t(49) = 21.48$, $p < .000$ in favor of the posttest.

Table 6

t-Test Results for the Differences Between the Experimental Participants' Pretest and Posttest Scores in Chemistry

Intervention	N	M	t- value	df	Sig. 2-tailed
Pre-test Post-test	50	49.74	21.48*	49	.000

$p \leq .05$

The null hypothesis, which states that no significant difference would exist between the pretest and posttest scores in Chemistry among the participants in the experimental group, was rejected. Analysis of the data revealed the following findings:

i. The experimental students' chemistry scores shifted from "Fair" in the pretest to "Very satisfactory" in the posttest.
ii. A significant difference existed between the pretest and posttest scores in Chemistry among the participants in the experimental group, in favor of the posttest.

Conclusion

Learning must be based on the learners' capacity to learn. The new development in theories about how well learners acquire the greatest store of knowledge is called "cognitive learning". Based on this new development, the amount of reinforcement from concrete to formal pattern of intellectual development necessary for learning physical science may be relative to the learners' performance at their cognitive level (Ornstein; as cited in Arce, 1997). Skinner believed in teaching in which learners acted the way they did because they had been reinforced for behaving in a certain manner. Students' behavior could be modified by guiding the students through the learning process using carefully arranged reinforcement. Reinforcement in the form of programmed instruction involves carefully arranged or sequenced learning objectives written in bi-directional spiral form. Skinner's Reinforcement theory was the thread to weave the mechanics of programmed instruction together. This theory has offered a new insight into addressing the problem confronting teachers, such as, getting students to become successful learners. In Phase I, the findings of the present study were in agreement to that of Skinner and his advocates who claim that programmed instruction is a better teaching strategy in dealing abstract lessons. Data in this study showed the items in the programmed instruction in Chemistry for secondary students as "Excellent" and "highly acceptable" as evaluated by teachers. Factor analysis results also indicated that all items were valid factors for their respective administration. This study confirms that of by Ticao (1986). As teachers plan their daily lessons, they have to identify the target groups' nature, readiness, and capacity. Instructional designs and appropriate teaching strategies must also be provided. Moreover, learners' capacity to learn abstractly depends on the nature of the development of their mental structure with stimulation from their outside environment. Programmed instruction as a learning material has subject matter broken down into small steps (frames), allowing for self-pacing, and providing feedback.

This study promoted the use of programmed instruction with effectiveness on students' performance, specifically, in dealing with highly abstract lessons in chemistry. Programmed instruction in textual form was used to present lessons from simpler to higher skills as shown by the numbered frames, evaluated daily lesson, and students' score. Programmed instruction reinforces correct behavior immediately either by controlling and advancing the next frame or by displaying to students the correct answer. However, this study contradicts the findings of Cracolice and Abraham (1996), that programmed instruction as teaching strategy/material produces small, positive effects on students' performance. In contrast, some data showing experimental students' Chemistry scores improving from fair to excellent with programmed instruction imply that experimental participants' consistently perform better with highly abstract lessons written in bi-directional spiral pattern. This study further contends claimed that successful completion of the program by the students' demonstrated the students understanding of the material. Furthermore, it implies that the students' behaviors were recorded for each frame so that, knowledge of their understanding of each part of the lesson (learning frames) was easily obtained. This indicates that learning behavior takes place under the right conditions.

Moreover, among the students in this study, the pretest and posttest scores in Chemistry of the experimental participants were significantly in favor of the posttest. This result also implies that programmed instruction as a method of teaching can help schools become more efficient. It points to the fact that the more able students could work through a program as rapidly as they could; while less able students, although taking more time to complete a program, would learn just as much as the more able ones.

In education, teacher practice of moving a whole group of students by means of using a teaching strategy most appropriate to the subject matter. Hence, the programmed instruction method can be made an alternative technique in teaching secondary Chemistry. The result also imply that programmed instruction significantly helps out students to learn basic skills gradually at their own pace, particularly when thinking processes in chemistry are carefully implemented. Likewise, programmed instruction developed Chemistry skills in the experimental group participants as they are given strong foundations in chemistry by the programmed instruction technique. Thus, teaching with programmed instruction method would improve performance of learners at the cognitive level. It challenges Chemistry teachers to adopt a technique most fitting to the highly abstract lessons in Chemistry where students are only at concrete level. Innovative instructional design and appropriate teaching strategy must be provided; Hence, the use of programmed instruction to uplift students' performance. If a programmed instruction as a teaching technique/material in secondary Chemistry imply that if taken seriously, it could improve learners' Chemistry performance. Following Lev Vygotsky's theory (1978), it is proven that in highly abstract learning situation, the importance of students' social interaction in cognitive development is recognized specifically by the use of programmed unit instruction.

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