SECONDARY SCHOOLS CHEMISTRY TEACHERS' COMPETENCIES: INPUTS TO A PROPOSED MODEL FOR STAFF DEVELOPMENT

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by

Mrs. Cosette C. Oliva

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A P P R O V A L S H E E T

This dissertation entitled **SECONDARY SCHOOLS CHEMISTRY TEACHERS' COMPETENCIES: INPUTS TO A PROPOSED MODEL FOR STAFF DEVELOPMENT,** was prepared and submitted by MRS. COSETTE C. OLIVA, who having passed the comprehensive examination with a rating of **PASSED,** is hereby recommended for oral examination.

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The researcher,

C. C. O.

ABSTRACT

This study aimed to determine the competencies of the high school chemistry teachers in Eastern Visayas that can be used as inputs to a proposed model for staff development. The normative-descriptive method of research was employed in this study using questionnaires –checklists developed by the researcher and validated by subject matter specialists for content and by non-respondent teachers and students for readability and clarity of instructions. The data was gathered during the second semester of the school year 1990-1991. In Eastern Visayas there is an acute shortage of chemistry teachers with appropriate educational qualifications and training; the chemistry teachers are not fully confident of their knowledge of chemistry concepts particularly carboxylic acids and esters in organic chemistry; properties of equilibrium constant and calculations at equilibrium in chemical equilibria; molecular geometry in covalent and hydrogen bonding; electrochemical series in electrochemistry; buffers in pH concept; and quark theory. They feel that they cannot perform proficiently laboratory operations such as dispose acid/toxic waste, select a substitute for a given chemical, calibrate volumetric instruments, do ignition, identify terminals of galvanometer, do simple dialysis, do electroplating, use a calorimeter, use pH meter, do paper chromatography, select proper indicator for titration, identify terminals of ammeter, use dessicator, use an autoclave, do column chromatography, do thin layer chromatography, do refluxing, and operate a spectrometer. The teachers feel competent with the four major teaching methods, namely: lecture-demonstration, laboratory activity, directed study, and problem solving, but sparingly use the last two in teaching concepts.

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THE PROBLEM AND ITS SETTING

Introduction

Science plays a decisive role in national development. But scientists have come to realize that proper development cannot be safeguarded unless science and its spirit become an integral part of the social structure of the nation. In a world that is becoming more and more dependent on the products of science and technology, science education must early enough be appreciated by the citizenry for what it can offer, to help transform society for the better. Science must be used by the Filipinos as his handmaid for growth and the promotion of equity and peace. But such a goal will not be reached unless we start and improve the quality of science education especially of the breeder sciences in the secondary level of the educational system. The role of the secondary school science teacher is crucial in the stages of the training of the future scientist. The kind of instruction given at the secondary level has a far reaching influence in a student's thinking whether he stops schooling, pursues another field, or continues to study science courses.

For us concerned with the future growth and development of our country through science and technology

the deteriorating quality of instruction in our schools especially in the breeder sciences furnishes a worrisome scenario of young minds not getting off to a right start in science education. The success of our national efforts to achieve a respectable level of economic and socio-political prosperity depends in no small measure upon the efficiency of our educational system. The implication of this state of affairs upon our secondary and tertiary schools is great. Follosco (1990) called upon our institutions of higher learning to produce the manpower needed for the country's vision to become a newly industrialized country by the year 2000. Chemistry is among the several fields of specialization in the sciences which must be developed to man the research and development sector in pursuit of this vision but it is lamentable to note that the greatest attrition at the college of arts and sciences are in chemistry and mathematics. Could it be due to the ineffective methods, inappropriate curriculum materials, or unprepared high school graduates ? If we are to prepare our students effectively for this modern age our secondary and collegiate programs must be given a hard look. Many Chemistry instructors at the tertiary level complain of the apparent weakness of chemistry instruction at the secondary level. A common observation is that college students have many misconceptions of basic chemistry principles and theories. The process of unlearning, of correcting a

misconception, is always more difficult than that of learning a new thing. Misconceptions of basic principles also have a very serious effect on future learning.

The weakness of science and technology education has been pointed out for some time by science educators. Notable among them were those cited by Professors Lucille Gregorio and Vivien Talisayon of the University of the Philippines Institute of Science and Mathematics Education in a recent issue of the Philippine Chemical News dated June, 1990. Professor Gregorio observes that one of the major drawbacks is the lack of time given to science as well as the incorrect teaching approach. Dr. Talisayon on the other hand, noted the dearth of qualified science teachers as she pointed out the danger of such teachers creating misconceptions about science in their students.

Teaching a science course is a very exacting job. Chemistry, especially, demands from the teacher accurate knowledge of content and proficiency in laboratory skills. Sad to note, presently only 15.4 % of chemistry teachers are qualified to teach the subject (PCN, June, 1990). Talisayon therefore, stressed the need to "go full-blast" in teacher retraining to upgrade their qualifications. To start with, Magno (1981) suggested, a situational scanning of the teachers' competencies have to be effected.

Thus, spurned by the desire to help upgrade the quality of secondary chemistry teaching in Eastern Visayas in the

face of the above cited dilemma, the researcher decided to pursue this research starting with the study of the teachers' competencies which can be used as explicit bases in planning for a staff development program that will serve the particular needs of the chemistry teachers in the region.

Statement of the Problem

This study determined the competencies of the high school chemistry teachers in Eastern Visayas that can be used as inputs to a proposed model for staff development. Specifically, it attempted to answer the following questions:

1. What is the profile of chemistry teachers in Eastern Visayas as indicated by their
   1.1. degree finished;
   1.2. units or semester hours of chemistry subjects earned;
   1.3. in-service trainings attended; and
   1.4. teaching experience ?
2. What is the perception of chemistry teachers in Eastern Visayas of their competencies in terms of
   2.1. knowledge of concepts;
   2.2. proficiency in laboratory skills;
   2.3. use of teaching methods; and
   2.4. use of assessment techniques to evaluate students' learning ?
3. What is the chemistry students' perception about

their extent and facility of learning the chemistry concepts and laboratory skills ?

4. Is there a significant relationship between the chemistry teachers' perceived competencies in knowledge of chemistry concepts and proficiency in laboratory skills and that of the students' perception of their extent and facility of learning the concepts and skills ?

Null Hypotheses:

From the specific questions above, the following null hypotheses were formulated:

1. There is no significant relationship between the chemistry teachers' perceived competencies in knowledge of concepts and the students' perception of their extent and facility of learning them.
2. There is no significant relationship between the chemistry teachers' perceived proficiency in laboratory skills and the students' perception of the extent and facility of learning them.

Theoretical Framework

This study is anchored on Sutaria's concept that "an up-to-date cataloguing of teachers' competencies is basic to planning pre-service and in-service training programs for teachers" (Sutaria, 1974). She stressesd that the

kaleidoscopic nature of education necessitates a frequent redefinition of the teacher's role and re-examination and consequently restructuring of their competencies in order that the teacher can truly educate the young, i.e., help them through life, to learn in order to think freely and critically, to learn to love the world and make it more human, to learn to develop in and through creative work, and prepare for more effective participation in the social process. She further asserted that:

> . . . if teachers are to be efficient and effective in the discharge of their duties and responsibilities and if they are to play the role they are expected to assume in national development, they must be adequately tooled to meet the requirements of the educational program.

This brings us to the assumptions underlying the use of students' perceptions and of self-assessment to determine the teachers' competencies in this study. Griffin (1983) rationalized the validity of perception as an assessment or evaluation measure by arguing that despite the truism that perceptions may not be verifiable, they are present and active. His stand on the issue is that:

> If one believes something to be so, that belief will have an impact upon related phenomena. And for staff developers, it maybe inconsequential in the grand scheme of things that a number of teachers believe that

> the findings of research on teaching are inaccurate or flawed, but in terms of program operations, it is important to acknowledge the perceptions and act on them towards some desired end.

On the issue of student perception, Martin (1968) asserted that, while it may be true that students have been no more effective than the faculty and administration in speaking creatively to the problem of institutional reforms, lack of public obligation and vested interest allows them a certain candor in speaking up what they feel and perceive on matters affecting them. The necessity of using this group in evaluation is also stressed by Dickey (1971) when he said:

> . . . we cannot rely solely upon the judgment of a group of administrators and faculty members. We have a real obligation to ask the students to give their frank and honest opinion on the institution, its institutional staff, its curriculum, its services, and the total program of which the student is a vital part.

From their review of teacher evaluation processes, Darling-Hammond, Wise, and Pease (1983) reported that the approaches used to evaluate teachers seek to measure very different aspects of teaching and the teachers and concluded that research has not identified a teacher evaluation method that is unvariably successful. This is so because

the evaluation depends on different conceptions of teaching work: as labor, as craft, as a profession, or as an art. As labor, teacher evaluation focus on the teacher's professional knowledge and skill; as craft, evaluation focus on the teacher's individual and collective interaction with students; as a profession, his personal insights; and as an art, encompasses all the elements of the first three views mentioned.

Mitchell and Kerchner (cited in Darling-Hammond, et al. 1983) assert that teacher evaluation involve both self-assessment and assessment of others. Fenstermacher (cited in Darling-Hammond, et al. 1983) while corroborating Mitchell and Kerchner's stand, goes further by saying that:

> . . . if the purpose of evaluating is to change the practices of those who teach, it is necessary to some extent to come to grips with the subjectively reasonable beliefs of teachers. It incorporates and gives full weight to teachers' beliefs and intentions in assessing what they do and in guiding them towards useful course of action.

Hence, for the prime reason that the result of this research will be used as inputs in planning for a proposed model for staff development of chemistry teachers, the teachers' self-assessment and their students' perceptions are relied upon heavily in determining the teachers' competencies.

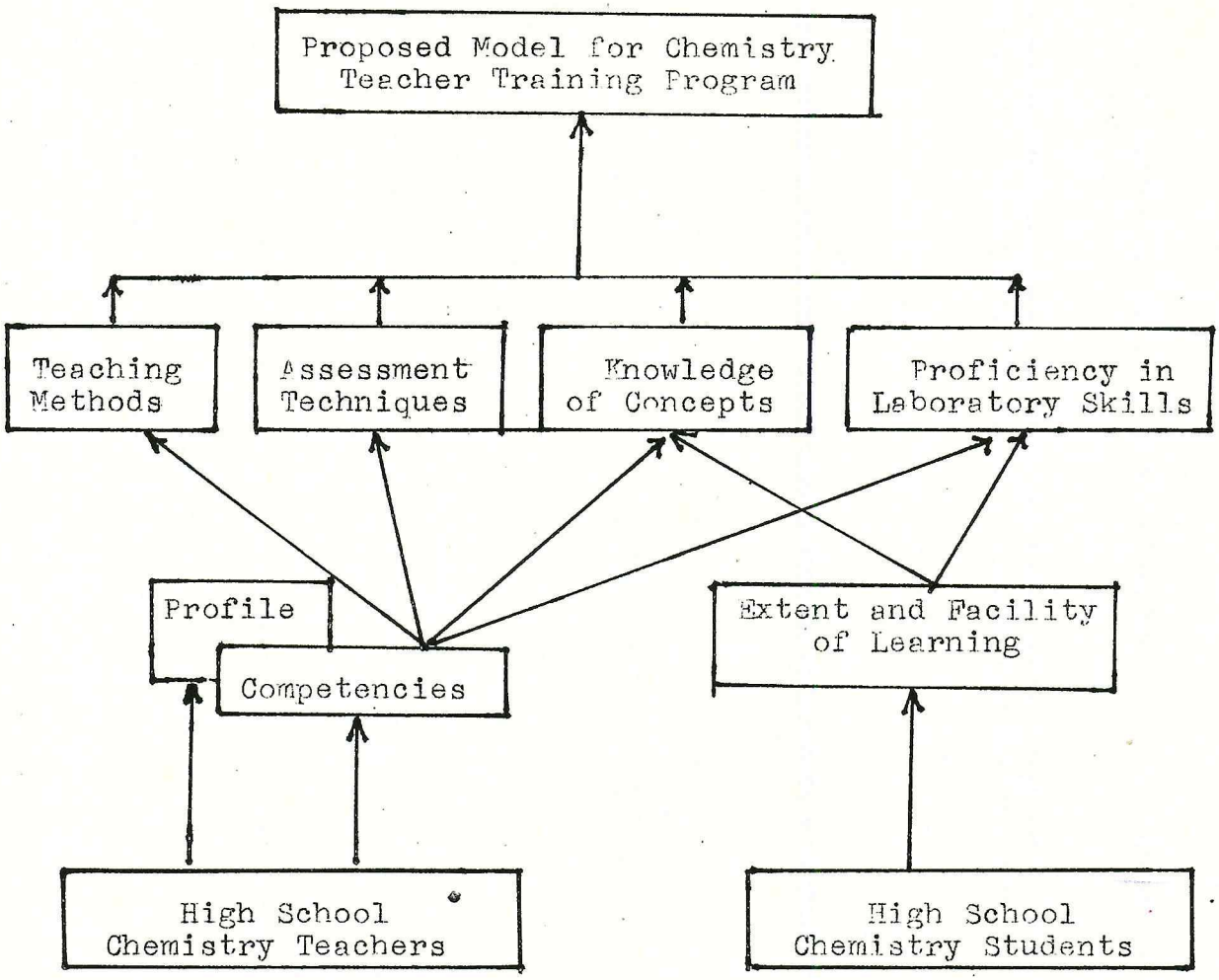

Figure 1. The Paradigm of the Study

Conceptual Framework

The conceptual framework as evolved from the ideas and theories cited in the preceding section is illustrated by the paradigm in Figure 1.

High school chemistry textbooks, laboratory manuals, teacher's guides, and courses of study were reviewed to come up with an inventory of chemistry concepts and laboratory skills that were incorporated in the data-gathering instrument consisting of questionnaire-checklists for the subjects of the study. The questionnaire-checklist for teachers was used to gather data about their profile and their self-assessment of their competencies in terms of their knowledge of concepts, proficiency in laboratory skills, teaching methods, and assessment techniques. The questionnaire-checklist for students was used to gather data about their extent and facility of learning the concepts and skills . The data obtained were statistically analyzed and interpreted to obtain a categorized listing of the teachers' competencies. These lists can be used finally as bases in the formulation of the proposed model for chemistry teacher training program for Region VIII.

Significance of the Study

This research is extremely important to curriculum planners and implementors of teacher-training institutions conducting in-service trainings for chemistry teachers in Region VIII. To effect a more efficient use of time,

energy, human, and material resources, training efforts can be zeroed in on chemistry concepts, laboratory skills, teaching methods, and assessment techniques where teachers expressed lack of competence.

Because the competencies are based on content analysis of high school chemistry textbooks, manuals, and teachers' guide, the data obtained in this study can provide curriculum developers of teacher training schools in Region VIII a relatively straightforward basis in restructuring their pre-service chemistry teacher training curriculum to keep pace with the state-of-the-art in chemistry teaching.

The dearth of qualified chemistry teachers revealed by the study can motivate education students to major in Chemistry as consequently, the demand for them is higher than those major in other subjects. The self-assessment instrument can motivate teachers to undertake self-improvement activities as professionals. The data obtained can also be used as basis in prioritizing resource materials development by curriculum developers in the region.

Likewise, the result of the study provides school administrators sound bases or reference in prioritizing allocation and procurement of resources needed to improve teaching competence and facilitate students' learning in chemistry in response to the current thrust in science and technology education.

Most of all the students, the ultimate beneficiaries, will receive better instruction from teachers who will be better prepared to teach after going through the model chemistry teacher training program specially designed to serve their peculiar needs.

Delimitation

This study was delimited to determining the profile of the secondary schools chemistry teachers in Eastern Visayas; their self-assessment of their competencies in terms of their knowledge of chemistry concepts, proficiency in laboratory skills, teaching methods, and assessment techniques used to evaluate students' learning of the major concepts and skills; their students' perception of their extent and facility of learning of the concepts and skills; and the relationship of the chemistry teachers' perceived competencies in knowledge of chemistry concepts and laboratory skills with that of the students' perceived extent and facility of learning them.

This study was conducted within the school year 1990-1991. The subjects were secondary school teachers currently teaching chemistry in selected schools in Eastern Visayas (See Figure 2) and their students in chemistry the previous year who were in their fourth year classes at the time the study was conducted. The subject schools were selected to represent all school categories - general, vocational, public, and private.

EASTERN VISAYAS (Region VIII)

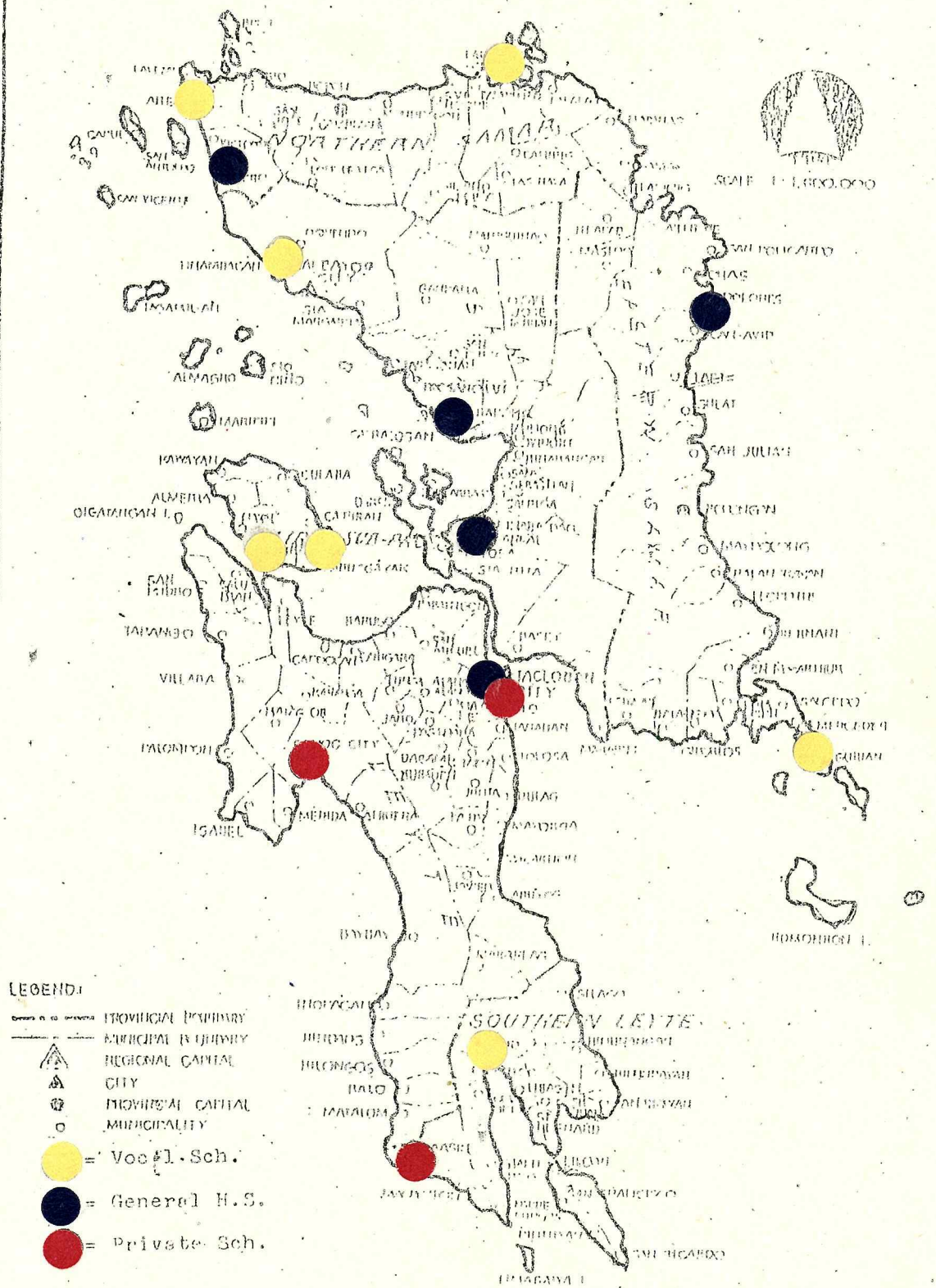

Figure 2. Location of Respondent Schools

The general high schools are public national and municipal secondary schools implementing the non-vocational curriculum. These are represented by Leyte National High School, Dolores National High School, Samar National School, Villareal Municipal High School, and Alegria Barangay High School.

The Vocational Schools are those implementing the vocational secondary curriculum represented by Southern Leyte School of Arts and Trades, Cabucgayan National School of Arts and Trades, Biliran National Agricultutral College, Laoang National Trade School, Balicuatro National Vocational School, Tiburcio Tancinco Memorial Institute of Science and Technology, and Felipe Abrigo Memorial School of Arts and Trades.

The private schools are represented by Saint Joseph College, Western Leyte College, and Leyte Colleges in Tacloban City.

Definition of Terms

In order to establish a uniform frame of reference, the following terms were defined to provide a clearer understanding of this research. The following terms used within the context of this study is intended to be interpreted as herein defined operationally and/or by the standard definition.

Assessment technique. This refers to the appraisal of what the students have learned or the effectiveness of the

learning process. It includes a variety of methods for securing and recording evidences needed to provide information on the students' progress. (Lardizabal, 1969).

Chemistry. Depending on the context wherein this term is used in this study, it may mean either as a science subject in the secondary curriculum or as a branch of science that deals with the composition, properties, and uses of matter, their changes, and the energy involved during change.

Concept Mapping. This is a practical technique of assessing students' understanding of the structure of a large body of knowledge that takes only a short time. In all its variations, its essential nature remains the production of a pattern of terms linked by relations, a coarse representation of how the respondent sees a substantial body of knowledge. (White, 1988).

Deductive Process. It is a method of teaching that starts with a generalization to the particular. (Lardizabal, 1969). This is used when the problem involves identification or explanation of a particular thing or phenomenon by use of principles or generalizations already known. (Coe, 1950),

Directed Study. This is a teaching method in which the learning activities are done in school under the teacher's direction and with his assistance and guidance. It can use laboratory, experimental, or research teaching procedure. (Coe, 1950).

Essay. As a technique to assess learning, refers to the free response type in which no completely right or wrong answers have been predetermined, in which there is room for much variety in the answers and divergence of opinion, even divergence from the opinion of the assessor. (Mathews, 1972).

Inductive Process. This method is the opposite of the deductive process. It involves the search for a new or unknown principle, rule or definition. (Coe, 1950)

Laboratory Activity. This is a teaching procedure dealing with first hand experiences regarding materials or facts obtained from investigation or experimentations, also called research method because the science classroom offers many opportunities for scientific investigations where learning activities dealing with original data that lead to the solution of problems are planned in the laboratory. (Lardizabal, 1969).

Lecture Demonstration. This is a formalized method of presentation of knowledge to a group of people. (Coe, 1950).

Model. This refers to a pattern of something to be made or reproduced. (Good, 1973).

Objective Test. This is a type of assessment technique that require fixed response such as multiple choice, true or false, supply missing data, matching type, etc., where the students respond exactly as his assessor has predetermined and gains a mark or he does not and gains nothing or incurs a penalty. (Mathews, 1972).

Perception. This refers to the individual's insight or understanding about the specific concept or skill in question.

Performance Test. This is an assessment technique used where the purpose is to determine relative development of skill. Good performance tests measure the students' ability to plan and execute his work. They measure speed, accuracy, and qualities of workmanship. The students' success is measured by the extent to which he attains predetermined standards of workmanship. (Lardizabal, 1969).

Prediction-Observation-Explanation. This is a technique to probe comprehension of a situation. The procedure is based on the classic model of research; a hypothesis is stated and reasons are advanced for why it might be expected to be true, data which bear on it are gathered and the results are discussed. In the investigation of comprehension, respondents are confronted with a situation and asked to write their prediction of what is going to happen. Reasons for the prediction are requested. The event is then allowed to take place and the respondents are asked to record what they observed. They are then required to explain any discrepancy between what they predicted and what they saw happen. (White, 1988).

Teacher Competence. This refers to the repertoire of competencies a teacher possesses. Overall competence is a matter of the degree to which a teacher has mastered a set

of individual competencies, some of which are more critical to a judgment of overall competence than others; an assessment of the quality of the teacher. (Adopted from Medley, cited in Darling-Hammond, et al, 1983)

Teacher Competency. This refers to any single knowledge, skill, or professional value position, the possession of which is believed to be relevant to the successful practice of teaching. Competencies refer to specific things that teachers know, do, or believe but not to the effects of these attributes on others (Darling-Hammond, et al, 1983).

Problem-Solving. This is an approach in teaching which uses both inductive and deductive processes of reasoning. (Coe, 1950).

Venn Diagram. Used as an assessment technique, is directed at the understanding of relations between a small number of related or similar concepts rather than comprehension of a situation. (White, 1988)

Word Association. This refers to a coarse assessment of understanding. The common procedure involves selection of a small number of key terms from the topic. These terms are placed or read one at a time before respondents who are asked to write for each term as many related terms as possible in one minute. The responses are analyzed for similarity index. (White, 1988).

Chapter 2

REVIEW OF RELATED LITERATURE AND RESEARCHES

Literature and researches reviewed which are related to this study are presented in this chapter to give the present study more substance and depth. However, because of the relative scarcity of literature dealing specifically with chemistry teaching, most conceptual literature reviewed and presented in this section are peripheral to the focus of this study but related in the sense that they deal in broader terms with science teaching, teachers' competencies and how they may be measured, and staff development concepts. Some materials reviewed simply urged that researches such as this present study be conducted.

Conceptual Literature

At the outset, the importance of science and technology and the significant role of science and technology education for national development and progress is nationally recognized as articulated in the 1987 Philippine Constitution, specifically Article XIV, Section 10, which states:

> Science and technology are essential for national development and progress. The state shall give priority to research and development, invention, innovation, and their utilization; and to **science and technology education**, training, and services. It shall

support indigenous, appropriate, and self-reliant, scientific and technology capabilities, and their application to the country's productive systems and national life.

In his paper presented at the ASAIHL Philippine Regional Seminar last August 30, 1990, Secretary Ceferino Follosco of the Department of Science and Technology called upon institutions of higher learning to develop the higher level manpower which include scientists, engineers, technicians, and other support personnel as he bared the shortage of science and technology manpower in the country needed to pursue the country's vision to become a newly industrialized country by the turn of the century in accordance with this 1987 constitutional mandate.

Za'rour (1983) and Lee's (1989) viewpoints are relevant to this issue. Za'rour holds that efforts to adapt science and technology education to the needs of rapidly changing societies lead to frustrations when educational aspirations are not fulfilled. Lee opines that "as we become more and more dependent on the products of science and technology, science education should aim at producing not only professionals who have careers in science but also scientifically literate society." Lee explains scientific literacy as:

The ability of individuals to read about, comprehend, and express an opinion on scientific matters and

> that in order to achieve scientific literacy, schools should seek to provide, firstly, a basic science education for every child, and secondly, a sound basis from which the scientifically gifted can attain the high standards that are expected of them.

In the same paper, Lee stressed:

> Schools should provide a common science curriculum up to the containment level. Thereafter, different science curricula can be offered so that well-informed students can make choices according to their needs, interest, aspirations, and capabilities; that science education should be for all, not just only for those who have the potentials to become scientists, technologists, or technicians.

The combined views aforementioned should lead us to give a hard look into the effectiveness of our educational system as agents called upon to effect our society's envisioned change towards industrialization.

In the Philippine setting, school curricula are uniform up to the secondary level. Andres (1989) alluded that "the secondary education is issue-laden compared to the elementary and the tertiary levels perhaps due to the fact that its role is to link elementary and tertiary education". Sutaria (1989) has reasons to cite the secondary education as the education system's weakest link aside from

statistics on participation rate, dropout rate, and national achievement test. To quote pertinent portions of her authorship in the reference cited, she said:

> While there is an oversupply of teachers, there is an acute shortage of teachers who are specially trained for science, mathematics, language, and technical subjects... It was reported that only half (53.8%) of the science teachers and only 61.6% of the mathematics teachers are qualified to teach the subject. The situation is worse in specialized subjects like chemistry and biology. In the case of chemistry subject only one-third (32.2%) are qualified to teach.

Sutaria further reported that the NCEE and the CEM (Center for Educational Measurements) test results showed very related or almost the same result as the achievement test given by the Bureau of Secondary Education in 1983 where the lowest score per subject area were in science and mathematics.

These reviews and assessment of the state of science education in the secondary schools bring to light the assertion of Gage (cited in Andres, 1986) that "it is the secondary classroom teacher that is the key to what the educational program will be for the students".

And so curricular reforms geared towards the current thrust "focuses on teacher training both pre-service and in-service, and upgrading and standardization of facilities and equipment" Sutaria (1989).

Considering the present deficient preparation of a significant number of high school chemistry teacher while at the same time underscoring their crucial role in the stages of training future scientists, Varela (1981) suggested a more rigid screening of their qualifications than has been done so far as a pre-requisite to giving them corrective in-service opportunities.

Short (1985) aptly provides the variables of teachers' qualifications referred to by Varela as he pointed out that " teacher competence is moderated by the following variables: a) educational qualifications, b) length of teaching experience, and c) in-service trainings attended."

So does Wolotkiewicz (1980) aptly provides enlightenment and justification for faculty development in his following discourse:

> Faculty development is the chief means for improving education during a period of rapid growth in higher education, the mechanism of new programs and facilities with accompanying growth in staff. When growth is replaced by steady-state staffing and declining of faculty mobility, decreasing enrolment, and demand for accountability and greater productivity, faculty must recognize the need and be willing to embark upon comprehensive programs for examining what they are doing, how they are doing it, and what can be done toward improvement.

Nacional (1980) classifies faculty development program into two major types, vis.: developmental program and development activities. Under the development program the following are included: pre-service education, in-service education, continuing education, continued education, and staff development. On the typology of development activities , the following are listed: faculty meetings, demonstration councils, teachers' councils, study clinics, orientations and observations, cooperative endeavors, individual endeavors, group excursions, and teachers' communities. Individual endeavors include authorship, college work, research and experiment, inter and entra-school visitations, membership in organizations, and travel.

A clear-cut guide to visualize the concept of staff development is offered by Griffin (1983). He underscored that one way to classify staff development activities is to examine them in terms of their ideological and temporal distance from the school phenomena they are meant to influence. For example, he says that:

> Staff development activities that are farthest removed from the problem they are intended to address are typically broad-based and relatively comprehensive programs exemplified by advance degree courses of study in higher education institutions. These sets of graduate degree programs maybe given such titles as elementary education, secondary education, special

education, and the like, and tend most often to be planned and executed by professors and instructors whose orientation to professional growth of educators are both comprehensive in scope and quasi-theoretical in nature.

A mid-level set of staff development activities is composed of problem or issue-focused learning opportunities planned and put into practice by school system administrators and/or teachers. Workshops, institutes, and other similar group of strategies generally have a system issue as the object of attention. Such programs are dependent for succcess upon the participants' abilities to receive, process and act upon information received.

The third level of staff development activities is made up of those strategies that emerge from and are acted out in actual environment upon which an effect is expected to be demonstrated. In the case of teachers this set of growth opportunities is classroom based and institution oriented.

Related Studies

Several studies have shown that educational qualification alone is not enough predictor of competence or effectiveness in teaching chemistry.

Javier (1990) for example, found that teacher competence based on educational qualifications and attitude

inventory has no significant relation to teacher effectiveness in terms of student performance. The subjects of her study were 48 teachers and 4,335 high school students of the Roosevelt College system which include seven high school units located in Montalban, San Mateo, Cainta, Rizal; Marikina and San Juan, Rizal; and Homesite and Cubao, Quezon City. Javier used the Skinnerian approach which, as explained, is a behavior pattern of instruction that measures teachers' effectiveness in terms of students' achievement. She used the pre-test post-test scores to judge the teacher's ability to accomplish the stated task.

Almost the same finding was reported by Kho (1977). From the analysis of questionnaires returned by 207 secondary school teacher respondents in the 4th district of Cebu who responded to her study, there was no significant relationship between teacher competence and educational qualification, in-service trainings, experience, and supervisory assistance.

Similarly, Bato (1978) investigated the relationship of some personal and professional variables to conceptualize knowledge by 86 grade VI science teachers in 14 school districts in Pangasinan during the school year 1977-78. A science concept test was administered to the subjects of the study. The result, analyzed using chi-square test, revealed that the respondents had poor knowledge of biological science and physical science concepts for the grade level

they taught. This was so inspite of the fact that they were "qualified" in terms of civil service eligibility, attendance to various in-service training programs, and length of teaching experience.

There are also documented claims that pre-service and in-service trainings are rich in concepts but deficient in methods of science teaching (Florido, 1980; San Juan, 1976). In Florido's study, 28 teachers were asked to respond to a questionnaire on the in-service trainings they attended and their transcripts of records were examined to assess the pre-service preparation. She found that the curricula offered for the pre-service training of teachers were rich in science content but deficient in methods of teaching. The in-service training activities considered objectives, content, teaching strategies and evaluation. The elementary science curriculum was not presented. San Juan's study involved science teachers in the secondary schools of the province of Catanduanes. She found that 35 % of the science teachers did not have the fundamental knowledge of science teaching.

A number of studies were also conducted to find out specific approaches effective in teaching certain concepts (Emata, 1983; Castillo, 1974; Briones, 1982; Pili, 1984). Emata investigated the effect of using atomic orbital models as instructional materials to supplement the teacher's discussion of a lesson. Achievement tests given to four

chemistry classes divided into experimental and control groups showed that achievement of students in chemistry was enhanced by the use of atomic orbital models. This disproved earlier findings of Castillo that the learner's abstract thinking development suffered as a result of using ready made atomic and molecular models. Castillo's historical analysis-survey aimed to illustrate and teach organic chemistry with the use of atomic-molecular orbital models. A random sample of approximately two thousand high school students were asked to respond to a survey sheet to find out the extent and popularity of either commercial or homemade atomic and molecular models and whether the organic chemistry portion is included and if so whether atomic and molecular models are used in teaching the topic. Results showed that the use of molecular models was very minimal. Briones's study done during the school year 1981-82 compared the effectivity of the modified individualized approach and the lecture-discussion method of teaching high school chemistry. The results of a teacher-made achievement tests given to 70 third year high school students showed that the two methods did not differ significantly in terms of student achievement. Pili's study investigated the effects of the Piagetian-based learning cycle approach on the learning of chemical reactions and equations, a unit in general chemistry. This approach made use of concrete observations from results of laboratory activities from which to derive

abstract thinking involved in writing the chemical equations. Conducted during the latter part of the first semester of the school year 1983-84, a sample of 212 first year students were assigned to experimental and control groups. A teacher-made test was used to determine achievement. Results showed that achievement of the desired instructional objectives of chemical reactions and equations can be improved by using the Piagetian-based learning cycle.

Very recent researches on chemistry teaching and teachers conducted in other places vary in focus but incidentally reported findings about chemistry teachers' academic qualification as they relate to other factors. Fedoc (1988) for instance compared the characteristics of high and low ranking schools in the Notre Dame Educational Association Year-end Achievement Test in Chemistry as she aimed to determine the best predictor of school performance in the test. Fifty three NDEA high schools who were subjected to the NDEA Achievement Test in Chemistry were ranked and the top and bottom one-third were identified. The top one-third were classified as the high ranking schools; the bottom one-third were classified as low ranking. There were 18 schools for each category. These two groups were compared in terms of the following characteristics: professional qualifications of their Chemistry teachers (degree, years of teaching the subject, attendance to NSTA-sponsored Summer Science Institute),

educational qualification of the principals, average class size, school location and availability of facilities and chemical in the science laboratories of the schools. Findings of the study fairly relevant to the present one is that attendance of chemistry teachers in Summer Science Institutes and the availability of facilities of the science laboratory were top predictors of school performance in chemistry.

Galit (1989) evaluated the effectiveness of the Summer Science Institute on the achievement of secondary school chemistry teachers in Region XI. The subjects of the study were 30 participants of the 1988 Summer Science Institute at the Regional Science Teaching Center at Notre Dame of Marbel College, and the 92 respondents who attended the echo seminars conducted by the SSI participants at the division level during the school year 1988-89. The instruments used were: a 90-item multiple choice type Achievement test in Chemistry prepared by the Up Science Education Center (now UP-ISMED) based on the contents of the text Chemistry in Our Environment, and a questionnaire checklist on implementation, and a teachers' personal data form. The findings revealed that there was a significant positive change in the participants' chemistry knowledge as a result of attendance in Summer Science Institutes; the trainees were found to have mastered 32 of the 90 items prior to the training; 30 items showed significant positive performance

changes, while 28 items have yet to be learned even after the six weeks of training; and the participants were found weak in the application of basic concepts in chemistry. The significant recommendations are: non-chemistry majors should be given priorities in the selection of chemistry participants to the Summer Science Institutes; the holding of similar programs in the future should consider the appropriateness of the training to local needs.

Dapo (1986) determined the degree of job satisfaction of chemistry teachers in the public high schools and the relation of this to their teaching performance. Thirty five chemistry teachers in 17 municipal and national high schools in the division of Albay and Sorsogon were involved in the study. He found that in general, teacher variables such as civil status, sex, age, educational background, years of teaching experience, undergraduate units earned in chemistry and number of preparations per week have no significant relationship with job satisfaction and the teaching performance; in terms of academic attainment over 70 % had taken units towards MA and two were graduates of Master's degree. In spite of their high educational background only nine out of 35 respondents were academically qualified to teach chemistry. Majority had taken only six to ten undergraduate units in chemistry.

The extent of utilization of available community resources by chemistry teachers from public secondary

schools in Manila was investigated by Pasiculan (1988) during the school year 1987-1988. The teachers were asked to indicate on a 5-point scale the way they use each specific resource. Findings and conclusions that have provided additional insights significant to the present study were: the materials and activities most commonly used by teachers are those easily found and easy to prepare; Activities and topics involving long processes are among the least used items; there is a significant difference in the extent of use of resources by teachers with different academic backgrounds but no significant difference was noted between teachers who only vary in their length of experience in teaching chemistry.

Villaflor (1987) investigated the relationship of teachers' attitude, perceived difficulty of concepts, and actual performance in the achievement test in chemistry of 59 high school chemistry teachers in the Division of Cebu for the school year 1986-87. The findings showed that the teachers of Cebu have poor attitude towards teaching of chemistry. They perceived the topics on bonding, periodicity, and redox to be difficult to teach. The error pattern showed that the teachers commit mistakes on questions that require a higher level of cognition such as application and analysis. The pattern also showed that more errors are committed on questions that belong to the more advance concepts. Further finding is that there is a

significant relationship between attitude toward teaching the subject and difficulty they have in teaching the subject. The recommendation worth noting is that teacher training should emphasize an analytical and critical approach to chemistry teaching and learning.

A nationwide study conducted by Magno (1981) revealed that half of the chemistry teachers in the field are inadequately prepared to teach high school chemistry and lack the competence and confidence that comes from the knowledge of content and skills. The study further disclosed that among teachers from six regions who were made respondents of his study, Region VIII had the lowest competency which was only within the range of fair and poor in both concepts and skills. It is significant to note that the most important concepts are the least known to the teachers in Region VIII and the least known skills are those which involve the use of instruments or special techniques. Since that time there has been no known follow-up study in Region VIII. The only study found somewhat relevant to chemistry instruction in Region VIII is that of Gatongay (1983) which attempted to compare students' performance in chemistry using a teacher-made test. Students of five selected public and private secondary schools in Northern Samar were made respondents. Significant findings were that concepts found to be mostly possessed by students in two schools are "identifying laboratory apparatus, existence of

atoms, and patterns of change" while the "concepts, skills, and abilities that need re-teaching were the nuclear model, acid, base, and salts, powers of number, and Avogadro's concept, etc."

Similarities and Differences of the Present Study with Those of Previous Studies Reviewed

To a certain extent the present study has a common aspect with the studies of Kho, Javier, Bato, Dapo, and Magno in that they all attempted to determine teachers' competence. Not identical in focus, the studies of Kho, Javier, Bato, and Dapo differ in bases and procedure of ascertaining the teachers' competence. This study used self-assessment instruments whereas Javier used pre-test post-test scores to determine teacher effectiveness; Bato used science concept test; Dapo depended on the chemistry units of teachers; Kho relied on the teacher's educational qualification, in-service trainings, experience and supervisory assistance as basis of teacher competence; and in addition to these Fedoc used Year-end Achievement test in Chemistry. Magno's study was nationwide in scope but limited to determining teachers' competencies in knowledge of concepts and laboratory skills whereas this study is limited to Region VIII but included teachers' competencies in teaching methods and assessment techniques in addition to concepts and skills. Both used self-assessment tools.

Villaflor also used perceptions in addition to achievement test results of her respondent teachers to identify the topics teachers found difficult to teach. Unlike the present study however, Villaflor and Magno, did not consider the students' counterpart perception of facility of learning the concepts and skills.

On the other hand, Gatongay used a teacher-made test administered to students to identify concepts and laboratory skills that students possess without considering the teachers' competency in teaching the same. Encompasing the studies of Magno, Villaflor, and Gatongay, the present study explored through self-assessment instrument, the teachers' competencies in specific concepts and skills, teaching methods used, and assessment techniques to measure students' learning, and related them to the students' facility of learning the same concepts and skills.

Experimental studies conducted by Emata and Briones to identify effective teaching approaches were limited to only one aspect each whereas this study explored teachers' competencies in all four major teaching methods and six assessment techniques including four state-of-the-art techniques of assessing learning in science.

Except that of Magno and Gatongay's, other studies had nothing to do with the prevailing chemistry teaching predicament in Region VIII and so cannot be used for the purpose to which the present study was conducted other than

providing insight in the formulation of the conceptual framework of this investigation and some possible inputs to the data gathering instruments. The rating scale and scheme of evaluating results in Magno´s study were adopted in the present study by the researcher.

Chapter 3

METHODOLOGY

This chapter describes the research design, subjects, sampling techniques, instrumentation, instrument validation, data gathering procedure, and data analysis and interpretation.

The Research Design

This study employed the normative-descriptive method of research aimed at determining the prevailing status of the competencies of the secondary school chemistry teachers in Eastern Visayas at the time the study was conducted. It focused on the following variables: teachers' profile, perception of their competencies on knowledge of chemistry concepts, proficiency in laboratory skills, teaching methods, and assessment techniques; and the students' perception of their extent and facility of learning the chemistry concepts and laboratory skills.

The principal instrument used to gather the data from the subjects of the study were questionnaire-checklists prepared by the researcher after careful analysis of the problem, diligent review of related literature and studies, and thorough documentary analysis of textbooks and references used in high school chemistry. The questionnaire-checklists were fielded and administered to

the intended respondents either personally or through the help of key personnels of the identified respondent schools. Three sampling techniques were used: purposive sampling for subject schools, total enumeration for the teachers, and systematic sampling for the students. The data obtained was encoded, organized, statistically processed, analyzed, and interpreted to finally come up with a categorized listing of teachers' competencies in terms of knowledge of chemistry concepts, proficiency in laboratory skills, use of teaching methods, and use of assessment techniques to assess students' learning. Descriptive statistics particularly weighted mean and Pearson product-moment coefficient of correlation were used to analyze the data. A categorized listing of the teachers' competencies was derived from the analysis and interpretation of data collected.

The Subjects of the Study

There were two groups of subjects of the study. One group were high school teachers teaching the chemistry subject in public and private secondary schools in Eastern Visayas. The other group were fourth year secondary school students from the same schools who have finished the high school chemistry subject the previous year.

The Sampling Technique

At least two secondary schools from each of the six provinces composing Eastern Visayas were selected thru

purposive sampling. The schools were purposively chosen to cut across public, private, and vocational schools in capital towns, cities, as well as barangay high schools. The schools with big fourth year enrolment during the school year 1990-1991 as shown in the records in the Secondary Education Division of DECSRO VIII were selected in order to get as much teacher respondents as possible. All the chemistry teachers in the selected schools were made respondents. Ten to twenty per cent of the students enrolled in the fourth year of each corresponding school were selected using systematic sampling. The student sampling was done by getting every fifth student present at the time of the administration of the questionnaire.

Instrument

Two sets of data gathering instruments were developed by the researcher. One for the teacher respondents and another for student respondents. The data- gathering instrument was a questionnaire-checklist type. An inventory of chemistry concepts, laboratory skills, appropriate teaching methods, and assessment techniques were evolved from a thorough documentary analysis of textbooks and laboratory manuals used in high school chemistry and other references in science teaching. These were utilized as inputs into the checklists of the data-gathering instrument.

The questionnaire for teacher-respondents consisted of two parts. The first part asked respondents to furnish

information about their educational qualifications covering their pre-service training in terms of credit hours or units earned in chemistry at the tertiary level, and of their in-service trainings in the form of attendance at summer institutes, film fora, demonstrations, etc. The second part consisted of a checklist of concepts and laboratory skills, teaching methods, and assessment techniques against which the respondents were to rate their own competencies by self-assessment using numerically coded ratings as follows:

For competencies in knowledge of chemistry concepts and laboratory skills:

A rating of 1 means you are confident of your knowledge of the concept / perform the laboratory skill proficiently;

A rating of 2 means you are not fully confident of your knowledge of the concept/you perform the laboratory skill with apprehension; and

A rating of 3 means that the concept/skill is completely unknown to you.

For competencies in using the teaching methods to teach the concepts or skills:

A rating of 1 means you are familiar with the method and use it often in teaching the concept/skill;

A rating of 2 means you are familiar with the method but use it sparingly in teaching the concept/skill; and

A rating of 3 means you never use the method because you do not know how to use it for the specific concept/skill.

For competencies in the use of techniques to assess students' learning:

A rating of 1 means you use the technique with ease in evaluating students' learning of the concept/skill;

A rating of 2 means you feel inadequate in using the technique to evaluate students' learning of the concept/skill; and

A rating of 3 means you are not familiar with the technique therefore cannot use it.

The questionnaire for student respondents also consisted of two parts. The first part asked them to furnish information about their age, sex, name and address of school, present level of enrolment, year they passed their chemistry subject, and their final rating in this subject. The second part contained a checklist of the same concepts and skills as that for chemistry teachers. They were asked to rate their perception of their facility and extent of learning the chemistry concept and laboratory skills using numerically coded responses as follows:

A rating of 1 means you learned the concept/skill fully and easily from your teacher;

A rating of 2 means you learned the concept/skill only partially from your teacher; and

A rating of 3 means you have no idea about the concept/skill at all.

Aside from the questionnaire-checklists, documentary analysis was also employed to gather other pertinent data, such as school enrolment, location of school, and type of school, from the Secondary Education Division of the DECS Regional Office.

Instrument Validation

The first draft of the questionnaire checklists were shown to the research adviser and colleagues for their comments and suggestions for improvement. After incorporating their suggestions, the improved version of the questionnaire checklist for teachers were validated for content by the Head of Physical Sciences Department of Leyte Institute of Technology and the Head of the Regional Science Teaching Center for Eastern Visayas based in Divine Word University, Tacloban City, and some chemistry teachers not from the respondent schools.

The questionnaire checklist for students were tried with some fourth year students in Samar State Polytechnic College for clarity of instructions and readability. Some minor revisions were made considering their suggestions and comments.

Data Gathering Procedure

The researcher requested and obtained permission from the Regional Director of the Department of Education Culture and Sports, Region VIII Office and the school administrators concerned to allow her to field and administer the questionnaire-checklists to the intended respondents. The instruments were administered by the researcher either personally or thru the help of friends in the schools and some DECSRO VIII Higher Education Division supervisors. In all cases, the respondents were allowed all the time they needed to answer the instrument but they finished answering it in an hour or more. The accomplished instruments were immediately retrieved and returned to the researcher.

Data Analysis

The data obtained from the questionnaire-checklists were encoded, organized, analyzed, and interpreted. The encoding of responses and their statistical treatments like frequency count, determination of mean weighted ratings, and Pearson product-moment coefficient of correlation were computerized to ensure accuracy of results.

The frequency count was used to analyze the teachers' profile in terms of their : degree finished and major preparations; number of chemistry units earned; in-service trainings attended; and teaching experience.

The mean weighted ratings were used to analyze the teachers' perceived competencies and the students' perceived extent and facility of learning. The mean weighted rating of each item was determined as follows:

$$\text{mean weighted rating} = \frac{\text{no. of resp. with answer of 1} \times 1 + \text{no. of resp. with answer of 1} \times 1 + \text{no. of resp. with answer of 1} \times 1}{\text{Total number of respondents}}$$

The teachers' competencies were determined from the mean weighted ratings of their responses. The teaching competencies included their: knowledge of specific chemistry concepts; proficiency in laboratory skills; teaching methods; and assessment techniques. The range of mean weighted ratings of teachers' responses were interpreted as follows:

For competencies in knowledge of chemistry concepts or proficiency in laboratory skills:

1.0 - 1.7 means the teachers know very well the concept or can perform the skill proficiently and therefore can teach it with confidence;

1.8 - 2.5 means the teachers know the concept only partially or can perform the skill with partial proficiency and therefore teach it with apprehension; and

2.6 and above means the concept is unknown to the teachers or they cannot do the laboratory skill at all therefore do not teach it.

For competencies in the use of teaching methods for each concept or skill:

1.0 - 1.7 means the teachers are familiar with the method and use it often in teaching the concept/skill;

1.8 - 2.5 the teachers are familiar with the method but use it sparingly in teaching the concept/skill;

2.6 and above means the teachers do not know the method therefore has never used it.

For competencies in the use of techniques to assess students' learning:

1.0 - 1.7 means the teachers use the technique with ease in assessing students' learning of the concept or skill;

1.8 - 2.5 means the teachers feel inadequate in using the technique to assess students' learning for the particular concept or skill;

2.6 and above means the teachers are not familiar with the technique therefore cannot use it.

The range of mean weighted ratings of students' responses were interpreted as follows:

1.0 - 1.7 means the concept/skill was fully and easily learned;

1.8 - 2.5 means the concept/skill was only partially learned or learned with difficulty; and

2.6 and above means the student has no idea about the concept nor can perform the skill at all.

The relationship between the chemistry teachers' perceived competencies in knowledge of chemistry concepts and proficiency in laboratory skills with that of the students' extent and facility of learning the concepts and skills were determined at .05 significance level using the Pearson product-moment formula as follows:

$$r = \frac{N\,EXY - (EX)(EY)}{\sqrt{[N\,EX^2 - (EX)^2][N\,EY^2 - (EY)^2]}}$$

where N = number of concepts or skills under study;

X = teachers' mean weighted ratings of each chemical concept or skill;

Y = students' mean weighted ratings of each chemical concept or skill.

Chapter 4

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter presents the data obtained from the respondents, followed by their analysis, interpretation, and discussion. The data consists of teachers' profile, students' perception of their learning, and the relationship of the variables.

Profile of Chemistry Teachers

The chemistry teachers' profile include their educational qualifications as indicated by their degree finished and major preparation, number of units in chemistry subjects earned, in-service trainings attended, and teaching experience.

Degree Finished and Major Preparations

The degree finished and major preparation of the teacher respondents presented in Table 1 shows that all of the 40 chemistry teacher respondents are Bachelor's degree holder but only six are Chemistry major and five are Bachelor of Science in Chemical Engineering; 14 are major in General Science, seven in Biology, two in Natural Science, and one each in Physical Science, Physics, and even Filipino. Three respondents did not specify their major preparation.

Table 1

Degree Finished and Major Preparation

Degree Finished	Major Preparation	No. of Teachers
B.S.E.	General Science	14
	Biology	7
	Physical Science	1
	Filipino	1
B.S.	Chemistry	6
B.S.Ch.E.	Chemistry	5
B.S.	Physics	1
A.B.	Natural Science	2
Not Specified	Not Specified	3
	T o t a l	40

Moreover, from Table 2 which shows the chemistry units earned by the respondents, only 27 have had General Chemistry in College broken down into 10 teachers who have earned 3-5 units, 14 with 6-10 units, and three with 11-15 units. Of these 27 teachers, 26 have units in Organic Chemistry, 20 have units in Physical Chemistry, and 14 with units in Advance Chemistry courses.

Table 3 shows that thirteen of the respondents do not have any Chemistry unit at all. Six of them are major in General Science, two in Biology, two who did not specify their major, and one each major in Physics, Natural Science, and Filipino.

Table 2

Chemistry Units Earned

Description	No. of Units 3-5	6-10	11-15	16-20	Total
Advance chemistry courses	2	4	5	3	14
Physical chemistry	11	7	2		20
Organic chemistry	12	12	2		26
General chemistry	10	14	3		27

Table 3

Chemistry Teachers Without Any Chemistry Unit

Major	No. of Teachers
General Science	6
Biology	2
Unspecified	2
Natural Science	1
Physics	1
Filipino	1
T o t a l	13

From the data obtained and presented above roughly three-fourths of the secondary school chemistry teachers are non-chemistry major and a considerable number have no chemistry unit at all. This fact is alarming considering that although chemistry is a physical science not exactly

unrelated to General Science, Biology, Natural Science, or Physics, it has its own unique set of highly interrelated concepts that require in-depth knowledge and understanding pre-requisite to being able to teach it effectively.

Presumably, being aware of this insufficiency of chemistry teachers with appropriate educational qualification and the consequent utilization of non-chemistry major to teach the subject, different agencies, associations, and educational institutions have conducted singularly or in consortium, in-service trainings for chemistry teachers in the form of summer institutes, seminars, workshops, film fora, and demonstrations. Chemistry teachers' attendance in these in-service trainings are listed in Appendix G and summarized in Table 4 in this text. The figures show that twenty three teachers have attended summer institutes that lasted from one to three summers; 10 have attended workshops; 19 have attended seminars; and only three and two have attended film fora and demonstration, respectively.

Inspite of these numerous in-service trainings for chemistry teachers offered, seven teachers have not attended any training at all; four of them being General Science major, one teacher who did not specify a major preparation, and one each major in Biology and Chemistry. The above information implies that a considerable number of chemistry teachers who are not chemistry major still remain unequipped

Table 4

Profile of In-Service Trainings of Chemistry Teachers

Major Preparation	No. of Teacher Resp.	Summer Inst.	Work-shops	Semi-nars	Film fora	Demo	No Trng
Gen. Science	14	6	4	5	3	1	4
Biology	7	6	1	3			1
Chemistry	6	5	1	3			1
BSCh E	5	1	1	4			
Nat. Science	2		1	2			
Physics	1	1					
Phy. Science	1	1	1	1			
Filipino	1	1	1	1			
Not specified	3	2				1	1
Totals.....	40	23	10	19	3	2	7

with competent knowledge of concept, laboratory skills, teaching method, and assessment techniques appropriate for chemistry teaching. The competencies gained even by those who have undergone seminars and workshops may still remain dubious in view of the fact that these seminars and workshops were conducted in short periods. As previously stated chemistry concepts are so interrelated that a particular concept cannot be fully grasped unless prerequisite concepts have been fully understood. The importance of a learned concept in turn cannot be appreciated unless its usefulness in learning the next concept or its practical application is realized. To develop adequate competencies in knowledge of the chemistry concepts, therefore, requires longer duration than that of

a single seminar or workshop (See Appendix H). Obviously, seminars and workshops offer piece-meal information or training to improve teaching competencies or to upgrade those who already have adequate or inadequate foundation in chemistry concepts and skills, teaching methods, or assessment skills.

The succeeding section dealing with the respondents' teaching experiences will give a clearer picture of their profile.

Teaching Experience

The data obtained from the respondents about their total years teaching experience and years experience in teaching chemistry are presented in matrix form in Table 5.

The table reveals that non-Chemistry majors (mostly General Science and Biology) have been utilized to teach high school chemistry since more than 25 years ago until the present, yet a considerable number of them do not even have units in chemistry nor had the chance to attend in-service trainings for chemistry teachers to equip them with the necessary competencies. Specifically, from the 16 out of 40 of the teacher respondents who have been teaching chemistry within the past four years or less, only two are major in chemistry and two are B.S.Ch.E., the rest are non-chemistry major. Furthermore, out of these 16, ten have less than five years, and four have 5-9 years total teaching experience. More intriguing is the fact that one teacher

Table 5

Teaching Experiences

Years in Teaching Chemistry	Total Years Teaching Experience: Below 5	5 - 9	10 - 14	15 - 19	20 - 24	25& above	Totals
20 - 24					2	2	4
15 - 19				4	1		5
10 - 14			3	2			5
5 - 9		7	2		1		10
Below 5	10	4		1		1	16
Totals	10	11	5	7	4	3	40

who did not specify his major with 17 years total teaching experience and another who is a Biology major who has 26 years total teaching experience were made to teach chemistry for a year.

These data obtained clearly reveal that in Eastern Visayas there is an acute shortage of chemistry teachers with appropriate educational qualifications and training. Their profile predisposed further research into their competencies in terms of knowledge of concepts and skills, teaching methods, and assessment techniques used to evaluate students' learning in chemistry.

Teaching Competencies

The competencies of Chemistry teachers focused on their self-appraisal of their confidence in their knowledge of specific chemistry concepts and proficiency in laboratory skills, their familiarity and frequency of use of the different teaching methods to teach each major concept and skill, and their facility in using the different assessment techniques to evaluate students' learning of the major concepts and laboratory skills.

The competency ratings are indicated by the mean weighted ratings of the teachers' responses to the questionnaire and interpreted according to their descriptive equivalence.

Knowledge of Concepts

Table 6 presents the mean weighted ratings of the chemistry teachers' perception of their knowledge of the chemistry concepts.

The data shows that the highest rating of 1.1 was on three concepts, namely: significant figures, chemical change, and pure substances; elements and compounds. This was followed by the rating of 1.2 on 16 concepts, the rating of 1.3 on 10 concepts, and the rating of 1.4 on 16 concepts. Other concepts obtained ratings 1.5 to 1.7. As a whole the data showed that , the chemistry teachers are confident with their knowledge of only 67 out of 75 specific concepts.

There were eight concepts rated low, that is, from 1.8 to 2.3, by the respondents. These are: carboxylic acids and esters, calculations at equilibrium,, reaction order, properties of equilibrium constant, molecular geometry, buffers, electrochemical series, and quark theory. This revealed limited over-all competence of knowledge in chemistry concepts on the part of the teachers because for instance, carboxylic acids and esters rated 1.8 are hydrocarbon derivatives rated 1.6; molecular geometry rated 2.0 is a consequence of covalent and hydrogen bonding rated 1.4 and 1.5, respectively; electrochemical series rated 2.1 is the practical result of the concept on electronegativity rated 1.5; quark theory rated 2.3 is the recent addition to the atomic theory (rated 1.2); properties of equilibrium

Table 6

Mean Weighted Ratings of Teachers' Perception of Their Knowledge of Chemistry Concepts

Concepts	Mean Weighted Ratings
Significant figure	1.1
Chemical change	1.1
Pure substances: elements and compounds	1.1
Electron configuration	1.2
Atomic theory: Structure and properties of the atom	1.2
Periodic properties of elements	1.2
Exothermic and endothermic reactions	1.2
Boyle's law of volume-pressure relationship of gases	1.2
Exponential numbers	1.2
Phase change and chemical change	1.2
Air pollution: causes and effects	1.2
Mixtures: Homogeneous and heterogeneous	1.2
Chemical reactions and equations	1.2
Charle's law of volume-temperature relationship of gases	1.2
Properties of liquids: surface tension,viscosity	1.2
Classification of matter	1.2
Law of definite composition	1.2
Metals and non-metals	1.2
Conversion to SI units	1.2
Kinetic molecular theory	1.3
Formula writing	1.3
Acids and Bases	1.3
Scientific methods and applications	1.3
Mole Concept	1.3
Properties of atoms	1.3
Family of elements	1.3
Period of elements	1.3
Molecular formula	1.3
Law of conservation of mass	1.3
Structural formula	1.4
Structural formula	1.4
Salts	1.4
Molar mass	1.4
Molar volume	1.4
Calculations involving formulas	1.4
Properties of colloids	1.4
Nomenclature of compounds	1.4

Table 6 (Continuation)

Concepts	Mean Weighted Ratings
Law of multiple proportion	1.4
Information from the periodic table	1.4
Chemical bonds: ionic, covalent, metallic	1.4
Indicators	1.4
Avogadro's number	1.4
Calculations involving equations	1.4
Avogadro's principle	1.4
Atomic size, electron affinity, ionization energy	1.4
Factors affecting reaction rate	1.5
Electron theory	1.5
Graham's law of diffusion	1.5
Specific heat and heat capacity	1.5
Orbital concept of the atom	1.5
Formation of colloids	1.5
Hydrogen bonds	1.5
Electronegativity	1.5
Hydrolysis	1.5
Oxidation-reduction reactions	1.5
Alcohols, aldehydes and ketones	1.5
Carbohydrates, proteins, and fats	1.6
Concept of pH	1.6
Isotopes	1.6
Radicals and polyatomic ions	1.6
Vapor pressure and relative humidity	1.6
Chemical equilibrium	1.6
Calculations on concentrations of solutions	1.6
Hydrocarbons	1.6
Colligative properties of solutions	1.7
Polar and nonpolar molecules	1.7
Breaking of colloids	1.7
Carboxylic acids and esters	1.8
Calculations at equilibrium	1.8
Reaction order	1.8
Properties of equilibrium constant	1.8
Molecular geometry	2.0
Buffers	2.1
Electrochemical series	2.1
Quark theory	2.3

constant and calculations at equilibrium both rated 1.8 are essential to understanding of the concept at equilibrium rated 1.6.

Key chemistry concepts are introduced in the high school Chemistry in simplified form but the danger is, simplification by one who lacks thorough knowledge of the concept may lead to misconceptions which are more difficult to unlearn later. Thus, the necessity of providing adequately in future chemistry teacher training programs for these eight specific concepts, namely: carboxylic acids and ester in organic chemistry, properties of equilibrium constant and calculations at equilibrium in chemical equilibra, molecular geometry in covalent and hydrogen bonding; electrochemical series in electrochemistry, buffers in pH concept, and quark theory in discussing atomic theory.

Laboratory Skills

The mean weighted ratings of the chemistry teachers' perception of their proficiency in laboratory skills is presented in Table 7.

The table shows that the highest rating of 1.2 was on the skill to weigh on a platform balance. This was followed by three laboratory skills rated 1.2, ninelaboratory skills rated 1.3, eight laboratory skills rated 1.4, four laboratory skills rated 1.5, six laboratory skills rated 1.6, and five laboratory skills rated 1.7. This means that the chemistry teachers perceive that they can perform 33 of

Table 7

Mean Weighted Ratings of Teachers' Perception of Their Laboratory Skills

Skills	Mean Weighted Ratings
Weigh on a platform balance	1.1
Prepare filter paper	1.2
Heating in a test tube	1.2
Read a thermometer	1.2
Use a microscope	1.3
Do filtration	1.3
Weigh on a triple beam balance	1.3
Read a volume measuring device	1.3
Determine boiling point	1.3
Graph data	1.3
Use a separatory funnel	1.3
Do sublimation	1.3
Transfer liquids	1.3
Do distillation	1.4
Store and handle chemicals	1.4
Use a cork borer	1.4
Cut and bend glass tubings	1.4
Regulate a bunsen burner	1.4
Prepare capillary tubes	1.4
Read graph	1.4
Determine melting point	1.4
Use a pipette	1.5
Use an oven	1.5
Collect gas by water displacement	1.5
Use a hydrometer	1.5
Prepare and use a burette	1.6
Do electrolysis	1.6
Use an analytical balance	1.6
Prepare solution of prescribed concentration	1.7
Use pH paper	1.7
Use a centrifuge	1.7
Do titration	1.7
Do crystallization	1.7
Dispose acid/toxic waste	1.8
Select a substitute for a given chemical	1.8
Calibrate volumetric instruments	1.8
Do ignition	1.8

Table 7 (Continuation)

Skills	Mean Weighted Ratings
Identify terminal of galvanometer	1.9
Do simple dialysis	1.9
Do electroplating	1.9
Use a calorimeter	1.9
Use pH meter	2.0
Do paper chromatography	2.0
Select proper indicator for titration	2.0
Identify terminals of ammeter	2.0
Use dessicator	2.1
Use an autoclave	2.2
Do column chromatography	2.2
Do thin layer chromatography	2.3
Do refluxing	2.3
Operate a spectrometer	2.3

the laboratory skills (rated 1.1 to 1.7) out of 51 listed in the questionnaire check-list.

There are, however, 18 laboratory skills rated low (1.8 to 2.3) by the respondents which implies that they can perform but with apprehension the following laboratory skills: dispose acid/toxic waste, select a substitute for a given chemical, calibrate volumetric instruments, do ignition,identify terminals indicator for titration, identify terminals of ammeter, use a dessicator, use an autoclave, do column chromatography, do thin layer chromatography, do refluxing, and operate a spectrometer.

The admitted lack of competence by the teachers in the above enumerated laboratory skills is easy to understand considering that skills such as to dispose properly acid and toxic waste and to select a substitute for a given chemical, both rated 1.8, and to select proper indicator for titration rated 2.0, are learned in more advance chemistry subjects which only 14 out of 40 teachers have.

Ideally, a chemistry teacher should know how to handle and dispose acids and toxic wastes properly to safeguard students and the immediate environment from harm. He should be able to pick-out from available and indigenious resources substitutes for a prescribed chemical so that the laboratory activity can be performed even if the prescribed chemical is not available which is most often the case in rural schools. To be able to do this requires more advance knowledge in chemistry, too.

Other laboratory operations such as pH determination, chromatographic analysis, refluxing, spectrometry, electrolysis and sterilization in autoclave requires special laboratory instruments and/or equipment which most of our secondary schools do not have. Nevertheless, chromatography, pH determination, dialysis and electroplating (an electrolytic process) can be done more simply although with less precision using local and/or improvised equipments. What is important is that concept learning is properly reinforced by concrete experiences of students while doing the activity if

properly guided by the chemistry teacher. The innovative skills cannot be expected from teachers with less than advance chemistry courses. These laboratory operations need to be provided for, among others, in modified form utilizing improvised materials in future faculty development programs for chemistry teachers.

Teaching Methods to Impart Chemistry Concepts

The 75 specific concepts enumerated in part A of the questionnaire are reduced into 19 supra concepts listed in this portion of the study for the purpose of finding out the teachers' self-assessment of their competencies in the use of different teaching methods to teach particular concepts. The mean weighted ratings of the teachers' responses is shown in Table 8 and are interpreted in terms of their pre-set descriptive equivalence.

The data obtained revealed that among the four major teaching methods, lecture-demonstration obtained the highest average mean weighted ratings by respondents, that is, 1.5, as compared with that of laboratory activity, directed study, and problem-solving which obtained average means of 1.7 and 1.9, respectively. This means that lecture-demonstration is the teaching method that teachers are most familiar with and most often use to teach practically all the chemistry concepts except measurements.

The other teaching methods which were rated 1.5 to 1.7 by teacher respondents which in turn implies that they

Table 8

Teachers' Competencies in the Use of Teaching Methods to Impart Chemistry Concepts

Major Concepts	Mean Weighted Ratings of Teaching Methods			
	Lecture-Demo	Laboratory Activity	Directed Study	Problem-Solving
1. Electrochemistry	1.7	1.7	2.1	2.0
2. Chemical equilibra	1.6	1.9	1.9	1.9
3. Organic compounds	1.5	1.8	1.9	2.0
4. Colloids	1.5	1.5	1.9	2.0
5. Electrolytes	1.6	1.5	1.8	2.0
6. Chemical bonds	1.4	1.9	1.9	1.9
7. Kinetic molecular theory	1.4	1.7	1.8	1.9
8. Thermochemistry	1.7	1.9	2.1	2.0
9. Chemical reactions	1.4	1.6	1.9	1.7
10. Atomic theory	1.3	1.7	1.8	1.9
11. Periodicity of properties of elements	1.4	1.8	1.8	1.8
12. Electron theory	1.5	1.9	1.9	1.9
13. Measurements	1.9	1.6	1.5	1.5
14. Stoichiometry	1.7	2.0	2.0	2.0
15. Classification of matter	1.5	1.5	1.6	1.7
16. Scientific method	1.5	1.5	1.7	1.7
17. Chemical laws	1.6	1.5	1.8	1.6
18. Chemical nomenclature	1.5	1.7	1.7	1.9
19. Mole concept	1.5	2.0	2.1	1.9
Average	1.5	1.7	1.9	1.9

are also familiar with and often use alongside with lecture-demonstration are: a) laboratory activity, to teach 11 of the concepts, namely; electrochemistry, colloids, electrolytes, kinetic molecular theory, chemical reactions, atomic theory, measurements, classification of matter, scientific method, chemical laws, and chemical nomenclature; b) directed study, to teach only four concepts, namely, measurements, classification of matter, scientific method, and chemical nomenclature; and c) problem-solving, to teach only five concepts, namely, chemical reactions, measurements, classification of matter, scientific method, and chemical laws.

The teaching methods that respondents rated 1.8 to 2.1 which means that they are familiar with but sparingly use are: a) lecture-demonstration, to teach measurement; b) laboratory activity, to teach chemical equilibra, organic compounds, chemical bonds, thermochemistry, periodicity of properties of elements, electron theory, stoichiometry, and mole concept; c) directed study to teach electrochemistry, chemical equilibra, organic compounds, colloids, electrolytes, chemical bonds, kinetic molecular theory, thermochemistry, chemical reactions, atomic theory, periodicity of properties of elements, electron theory, stoichiometry, chemical laws, and mole concept; and d) problem-solving, to teach electrochemistry, chemical equilibra, organic compounds, colloids, electrolytes,

chemical bonds, kinetic molecular theory, atomic theory, periodicity of properties of elements, electron theory, stoichiometry, chemical nomenclature, and mole concept.

The table further disclosed that with two major concepts, namely, classification of matter and scientific methods, the teachers are familiar with and often use all the four teaching methods which are rated 1.5 to 1.7. With chemical laws and chemical reactions the teachers are familiar with and often use lecture demonstration, laboratory-activity, and problem- solving rated 1.4 to 1.7 ; with measurements, laboratory-activity, directed study, and problem solving rated 1.5 to 1.6; with chemical nomenclature, lecture demonstration, laboratory-activity, and directed study rated 1.5 to 1.7.

Concepts where teachers are familiar with and often use only lecture-demonstration and lab-activity (rated 1.3 to 1.7) to teach them include electrochemistry, colloids, electrolytes, kinetic molecular theory, and atomic theory.

Concepts where lecture-demonstration (rated 1.4 to 1.7) is the only teaching method that teachers are familiar with and often use are chemical equilibra, organic compounds, chemical bonds, thermochemistry, periodicity of properties of elements, electron theory, stoichiometry, and the mole concept.

It is very evident from the above data that although teachers are familiar with directed-study and problem-

solving methods, they sparingly use these teaching strategies. Whatever their reasons is beyond the scope of this study. Nevertheless, these findings are useful in this study as they identified the teaching strategies or methods that must be given more emphasis in instruction in the proposed model for chemistry teacher training program.

Teaching Methods to Impart Laboratory Skills

The mean weighted ratings of the teachers' responses presented in Table 9 shows that, on the average, the respondents are familiar with and and often use the four teaching methods to impart the laboratory skills although laboratory activity obtained the highest average mean weighted rating of 1.5 whereas lecture-demonstration, directed study, and problem-solving obtained 1.7 each. methods to impart particular laboratory skills.

More specifically, the data revealed that laboratory activity which was rated 1.3 to 1.7 by the respondents is the method teachers are most familiar with and often use to impart to the students practically all of the listed laboratory skills except spectrometry (rated 2.0) and chromatography (rated 1.8).

Second to laboratory activity is lecture-demonstration (which was rated 1.4 to 1.7) to impart most of the skills except in spectrometry (rated 1.9), chromatography (rated 2.1), pH determination, use volumetric instruments,use electrical devices (all rated 1.8), and calorimetry (rated 2.1).

Table 9

Teachers' Competencies in the Use of Teaching Methods to Impart Laboratory Skills

Laboratory Skills	Mean Weighted Ratings of Teaching Methods			
	Lecture-Demo	Laboratory Activity	Directed Study	Problem-Solving
1. Do spectrometry	1.9	2.0	1.9	1.8
2. Do chromatography	2.1	1.8	1.8	1.9
3. Do pH determination	1.8	1.7	1.9	1.7
4. Sterilize	1.6	1.5	1.7	2.0
5. Electrolyze	1.5	1.6	1.7	1.9
6. Do common laboratory operations	1.7	1.5	1.8	1.6
7. Prepare solutions of specified concentration	1.4	1.6	1.9	1.8
8. Titrate	1.6	1.7	2.0	1.7
9. Weigh	1.4	1.3	1.6	1.5
10. Glass manipulation	1.4	1.4	1.4	1.5
11. Use volumetric instruments	1.8	1.5	1.5	1.6
12. Read calibrated instruments	1.6	1.5	1.4	1.6
13. Use electrical devices	1.8	1.6	1.7	1.7
14. Do distillation	1.5	1.3	1.4	1.7
15. Calibrate instruments	1.4	1.4	1.8	1.7
16. Do simple dialysis	1.7	1.7	2.0	1.9
17. Graph data	1.4	1.4	1.6	1.6
18. Do calorimetry	2.1	1.7	2.3	1.9
Average	1.7	1.5	1.7	1.7

The table also shows that teachers are familiar with and often use: a) all the four teaching methods rated (1.3 to 1.7) to impart to students five of the laboratory skills, namely, to weigh, manipulate glass, read calibrated instruments, distill, and graph data; b) three methods, namely, lecture demonstration (rated 1.4 to 1.7), lab-activity (rated 1.4 to 1.7) and problem-solving (rated 1.6 to 1.7) to impart the skills, namely, to do common laboratory operations, to titrate, and to calibrate instruments; c) only two methods, lecture-demonstration and laboratory activity, to impart to the students two of the skills, namely, to prepare solutions of specified concentrations (rated 1.4 to 1.6) and to do simple dialysis (rated 1.7); d) likewise, only two methods, namely, laboratory activity and problem-solving (both rated 1.7) to teach how to do pH determination; and finally, e) only laboratory activity (rated 1.7) to teach calorimetry.

The teachers claim they are familiar with but sparingly use: a) lecture-demonstration (rated 1.8 to 2.1) to teach spectrometry, chromatography, pH determination, use of volumetric instruments, use electrical devices, and calorimetry; b) laboratory activity (rated 1.8 to 2.0) to teach spectrometry and chromatography; c) directed study (rated 1.8 to 2.3) to teach spectrometry, chromatography, pH determination, common laboratory operations, calibration of

instruments, simple dialysis, and calorimetry; d) problem-solving (rated 1.8 to 2.0) to teach spectrometry, chromatography, sterilization, electrolysis, preparing solutions of specified concentration, simple dialysis, and calorimetry.

All of the above findings imply that teachers are familiar with all four teaching methods which they often use to teach the laboratory skills except spectrometry and chromatography. These last two laboratory operations after all are not commonly done in secondary chemistry classes.

Assessment Techniques to Evaluate Students' Learning of Chemistry Concepts

The mean weighted ratings of the teachers' responses to the questionnaire checklist on their competencies in using assessment techniques to evaluate students' learning of the major chemistry concepts in high school chemistry are shown in Table 10.

The data shows that among the assessment techniques objective test was rated highest by the respondents with an average mean weighted rating of 1.7 followed by essay test, prediction-observation-explanation, and performance test rated 2.0 each, then word association, concept mapping, and Venn diagram rated 2.2, 2.3, and 2.5, respectively. This means that, in general, the teachers find objective test the easiest technique to assess students' learning of chemistry concepts.

Table 10

Teachers' Competencies in Using Assessment Techniques to Evaluate Students' Learning of Chemistry Concepts

Major Concepts	Mean Weighted Ratings of Assessment Techniques						
	Essay Test	Objective Test	POE	Venn Diagram	Concept Mapping	Word Ass'n	Performance Test
1. Electrochemistry	2.0	1.7	2.3	2.8	2.6	2.2	1.8
2. Chemical equilibra	2.0	1.8	2.2	2.4	2.2	2.2	2.1
3. Organic compounds	1.9	1.7	2.1	2.5	2.3	2.2	2.0
4. Colloids	1.9	1.8	1.9	2.6	2.2	2.2	2.0
5. Electrolytes	2.1	1.8	2.0	2.6	2.3	2.2	1.9
6. Chemical bonds	2.1	1.6	2.2	2.6	2.3	2.3	1.9
7. Kinetic molecular theory	1.8	1.7	1.9	2.6	2.1	2.3	2.0
8. Thermochemistry	2.1	1.9	2.1	2.6	2.2	2.2	2.0
9. Chemical reactions	2.2	1.8	1.8	2.6	2.3	2.3	2.0
10. Atomic theory	1.9	1.7	2.1	2.5	2.3	2.3	2.0
11. Periodicity of properties of elements	2.1	1.7	2.1	2.5	2.3	2.2	2.0
12. Electron theory	2.0	1.8	2.2	2.7	2.3	2.2	2.1
13. Measurements	2.1	1.8	2.1	2.5	2.2	2.2	1.8
14. Stoichiometry	2.3	1.9	2.3	2.5	2.4	2.4	2.1
15. Classification of matter	1.9	1.7	1.8	2.5	2.1	2.1	2.0
16. Scientific method	1.7	1.7	1.9	2.4	2.1	2.1	1.9
17. Chemical laws	2.0	1.6	1.7	2.5	2.2	2.2	2.0
18. Chemical nomenclature	2.0	1.6	2.1	2.4	2.3	2.2	2.1
19. Mole concept	1.9	1.8	2.1	2.5	2.2	2.2	2.0
Average	2.0	1.7	2.0	2.5	2.3	2.2	2.0

The respondents rated objective test 1.6 to 1.7 in 11 concepts namely: electrochemistry, organic compounds, chemical bonds, kinetic molecular theory, atomic theory, periodicity of properties of elements, classification of matter, scientific method, chemical laws, chemical nomenclature, and mole concept.

They also use essay test (rated 1.7) with ease to assess students' learning of only one concept, that is, scientific method. Likewise, they use prediction-observation-explanation (rated 1.7) with ease to assess students' learning on chemical laws only.

Teachers use with ease both essay and objective test (rated 1.7) to assess students' learning of scientific method; also objective test (rated 1.6) and prediction-observation-explanation (rated 1.7) with chemical laws.

Although objective test is the most popular assessment technique used by chemistry teachers in assessing chemistry concepts they, however, rated eight concepts 1.8 to 2.3. This means they feel inadequate in using the technique with these concepts, namely: chemical equilibra, colloids, electrolytes, electrolysis, thermochemistry, chemical reactions, electron theory, measurements, and stoichiometry.

Moreover, they feel the same inadequacy with word association they rated 2.1 to 2.4, performance test they rated 1.8 to 2.1, and concept mapping they rated 2.1 to 2.4 to assess students' learning of all the chemistry concepts

except electrochemistry where teachers have no idea at all how concept mapping they rated 2.6, is used to evaluate it.

Similarly, they feel inadequate in using Venn diagram (rated 2.4 to 2.5) to evaluate students' learning of 11 concepts namely: chemical equilibra, organic compounds, atomic theory, measurements, stoichiometry, scientific method, classification of matter, chemical laws, chemical nomenclature, and mole concept.

Finally, they have no idea at all how Venn diagram (rated 2.6 to 2.8) is used to evaluate students' learning of the other eight concepts namely: electrochemistry, colloids, electrolytes, chemical bonds, kinetic molecular theory, thermochemistry, chemical reactions, and electron theory.

In the light of the above data obtained showing that the teachers' competencies in evaluating students' learning are limited to assessment techniques like objective test and to a more limited extent essay and prediction-observation-explanation only, enrichment of chemistry teacher training programs by inclusion of training with other assessment techniques such as, prediction-observation-explanation, Venn diagram, concept mapping, and word associatrion which are more appropriate for evaluating learning of some chemistry concepts.

Assessment Techniques to Evaluate Students' Laboratory Skills

The mean weighted ratings of the teachers' responses to the questionnaire-checklist on their competencies in using assessment techniques to evaluate the laboratory skills developed by students is presented in Table 11.

The data shows that performance test has the highest average mean weighted rating of 1.9 followed by objective test (rated 2.1), essay test and prediction-observation-explanation (both rated 2.2), word association (rated 2.3), and concept mapping and Venn diagram (rated 2.4).

These responses candidly reveal that the only assessment technique that the teachers can use with ease is performance test (they rated 1.7) but only to evaluate skills in doing common laboratory operations. They feel inadequate in using performance test and all other assessment techniques listed in the questionnaire-checklist to evaluate all other laboratory skills, if at all learned by the students.

In extreme cases they have no idea at all how to use: Venn diagram (they rated 2.7), to evaluate the skill in doing spectrometry and chromatography; and concept mapping (they rated 2.6) to evaluate skill in doing spectrometry.

In reality the most appropriate technique to assess laboratory skills is by performance test. However, the other techniques were included in the questionnaire-

Table 11

Teachers' Competencies in Using Assessment Techniques to Evaluate Students' Laboratory Skills

Laboratory Skills	Mean Weighted Ratings of Assessment Techniques						
	Essay Test	Objective Test	POE	Venn Diagram	Concept Mapping	Word Ass'n	Performance Test
1. Do spectrometry	2.4	2.5	2.4	2.7	2.6	2.5	2.4
2. Do chromatography	2.5	2.3	2.3	2.7	2.5	2.5	2.1
3. Do pH determination	2.3	2.2	2.2	2.5	2.5	2.5	2.1
4. Sterilize	2.2	2.2	2.2	2.4	2.4	2.4	2.0
5. Electrolyze	2.1	1.9	2.1	2.4	2.3	2.4	1.9
6. Do common laboratory operations	2.0	1.9	1.9	2.4	2.2	2.2	1.7
7. Prepare solutions of specified concentration	2.2	2.1	2.0	2.4	2.3	2.3	1.8
8. Titrate	2.2	2.1	2.2	2.4	2.4	2.3	2.0
9. Weigh	2.1	1.9	2.1	2.4	2.2	2.2	1.8
10. Glass manipulation	2.2	1.9	2.1	2.4	2.3	2.3	1.8
11. Use volumetric instruments	2.2	2.1	2.1	2.4	2.4	2.4	1.8
12. Read calibrated instruments	2.1	2.0	2.1	2.4	2.3	2.2	1.8
13. Use electrical devices	2.2	2.2	2.2	2.4	2.4	2.4	1.9
14. Do distillation	2.2	1.9	2.1	2.4	2.4	2.3	1.8
15. Calibrate instruments	2.2	2.1	2.1	2.4	2.3	2.2	1.8
16. Do simple dialysis	2.4	2.3	2.3	2.4	2.4	2.5	2.2
17. Graph data	2.2	2.0	2.1	2.3	2.3	2.2	1.9
18. Do calorimetry	2.3	2.2	2.2	2.3	2.5	2.4	2.1
Average	2.2	2.1	2.2	2.4	2.4	2.3	1.9

checklist to find out how the teachers would respond to them. The above pattern of their responses are proof of the matter. The sorry state, however, is the fact that can be gleaned from their responses that except for evaluating skills in doing common laboratory operations, they feel inadequate in using performance test to evaluate the other 17 laboratory skills.

The above findings implied that there is certainly a need to train chemistry teachers how to use performance test in evaluating the laboratory skills developed by the students as a result of their instruction.

Students' Perception About Their Learned Concepts and Laboratory Skills

Aside from the teachers' self-assessment, their competencies may also be gauged to some extent by their success in effecting students' learning. In this study, students' assessment of their learning was explored using a questionnaire-checklist containing an inventory of specific chemical concepts and laboratory skills exactly like those answered by the chemistry teachers. Similarly, their responses were indicated by their mean weighted ratings.

Concepts Learned

Table 12 shows the mean weighted ratings, arranged in increasing order, of the students' responses to the questionnaire-checklist exploring their self-assessment of

Table 12

Mean Weighted Ratings of Students' Perception of their Extent of Learning the Chemical Concepts

Concepts	Mean Weighted Ratings
Chemical change	1.3
Classification of matter	1.3
Pure substances: elements and compounds	1.3
Periodic properties of elements	1.4
Carbohydrates, proteins, and fats	1.4
Information from the periodic table	1.4
Mixtures: Homogeneous and heterogeneous	1.4
Metals and non-metals	1.5
Salts	1.5
Air pollution: causes and effects	1.5
Period of elements	1.5
Properties of atoms	1.5
Kinetic molecular theory	1.6
Phase change and chemical change	1.6
Law of conservation of mass	1.6
Family of elements	1.6
Hydrocarbons	1.6
Scientific methods and applications	1.6
Boyle's law of volume-pressure relationship of gases	1.6
Specific heat and heat capacity	1.7
Chemical reactions and equations	1.7
Charle's law of volume-temperature relationship of gases	1.7
Formula writing	1.7
Exponential numbers	1.7
Acids and Bases	1.7
Significant figure	1.7
Atomic theory: Structure and properties of the atom	1.7
Hydrogen bonds	1.8
Properties of liquids: surface tension,viscosity	1.8
Conversion to SI units	1.8
Chemical bonds: ionic, covalent, metallic	1.8
Atomic size, electron affinity, ionization energy	1.8
Oxidation-reduction reactions	1.8
Orbital concept of the atom	1.8
Calculations involving formulas	1.8
Molar mass	1.8
Law of definite composition	1.8

Table 12 (Continuation)

Concepts	Mean Weighted Ratings
Molecular formula	1.8
Exothermic and endothermic reactions	1.8
Electron configuration	1.9
Molar volume	1.9
Hydrolysis	1.9
Alcohols, aldehydes and ketones	1.9
Properties of colloids	1.9
Formation of colloids	1.9
Mole Concept	1.9
Molecular geometry	1.9
Polar and nonpolar molecules	1.9
Chemical equilibrium	1.9
Avogadro's number	2.0
Breaking of colloids	2.0
Calculations involving equations	2.0
Indicators	2.0
Nomenclature of compounds	2.0
Colligative properties of solutions	2.0
Electron theory	2.0
Law of multiple proportion	2.0
Properties of equilibrium constant	2.0
Calculations on concentrations of solutions	2.0
Electronegativity	2.0
Calculations at equilibrium	2.0
Structural formula	2.0
Radicals and polyatomic ions	2.1
Reaction order	2.1
Factors affecting reaction rate	2.1
Vapor pressure and relative humidity	2.1
Graham's law of diffusion	2.1
Avogadro's principle	2.1
Carboxylic acids and esters	2.1
Electrochemical series	2.2
Isotopes	2.2
Structural formula	2.3
Concept of pH	2.3
Quark theory	2.5
Buffers	2.5

the extent to which they have learned the chemistry concept from their teachers.

There are 27 specific concepts (rated 1.3 - 1.7) which students claim they have learned fully and easily from their teachers and 48 specific concepts (rated 1.8 - 2.3) which they learned only partially.

It is evident from the students' responses, then, that inspite of the teachers' claim of confidence in their knowledge of 67 out of 75 specific concepts, only 27 were learned fully and easily by the students. The wide gap, numbering 40 concepts, which the students had difficulty learning notwithstanding the teachers' "confidence" in their knowledge thereof, suggests factors other than teachers' knowledgeability of the concept that significantly determine the teachin-learning effectiveness. Prominent among the countless plausible factors could be inappropriate teaching method used.

Thus, the findings in this section served to confirm the need to study the teaching methods that teachers use in teaching a particular concept or skill. This aspect was already treated in the previous section on teachers' competencies in teaching method.

Laboratory Skills

The mean weighted ratings of the students' perception of their extent of learning the laboratory skills presentred in Table 13 shows that of the 51 skills listed they have

Table 13

Mean Weighted Ratings of Students' Perception of their Extent of Learning of Laboratory Skills

SKILLS	Mean Weighted Ratings
Heating in a test tube	1.4
Determine melting point	1.6
Use a microscope	1.6
Read a thermometer	1.6
Weigh on a platform balance	1.6
Transfer liquids	1.7
Graph data	1.7
Determine boiling point	1.7
Do distillation	1.8
Prepare filter paper	1.8
Read a volume measuring device	1.8
Read graph	1.9
Do filtration	1.9
Use a hydrometer	2.0
Weigh on a triple beam balance	2.0
Collect gas by water displacement	2.0
Regulate a bunsen burner	2.0
Use an analytical balance	2.0
Use an oven	2.0
Use a cork borer	2.0
Store and handle chemicals	2.0
Do crystallization	2.1
Do simple dialysis	2.1
Prepare capillary tubes	2.1
Use a separatory funnel	2.1
Do electrolysis	2.1
Cut and bend glass tubings	2.1
Select a substitute for a given chemical	2.2
Dispose acid/toxic waste	2.2
Calibrate volumetric instruments	2.2
Do sublimation	2.2
Use a centrifuge	2.2
Use pH paper	2.2
Select proper indicator for titration	2.3
Prepare solution of prescribed concentration	2.3
Do titration	2.3
Use a pipette	2.4
Do electroplating	2.4

Table 13 (Continuation)

SKILLS	Mean Weighted Ratings
Use pH meter	2.4
Do ignition	2.4
Use a calorimeter	2.4
Prepare and use a burette	2.5
Identify terminals of ammeter	2.5
Identify terminals of galvanometer	2.5
Use dessicator	2.5
Do paper chromatography	2.5
Do refluxing	2.5
Use an autoclave	2.6
Operate a spectrometer	2.6
Do thin layer chromatography	2.6
Do column chromatography	2.7

learned only eight skills (rated 1.4 - 1.7) fully and 39 skills (rated 1.8 - 2.4) just partially, from their teachers. They cannot perform at all four skills (rated 2.6 - 2.7) namely: use an autoclave, operate a spectrometer, and do thin layer or column chromatography.

These figures are strikingly incongruous with the teachers' claim that they can perform 33 of the skills competently and the other 18 they can perform although with apprehension. Regretfully, to delve into the reasons behind this incongruence of the teachers' perceived competencies and the students' learning of the laboratory skills is beyond the scope of this study.

The researcher is, however, inclined to believe that one reason is the lack of apparatus and equipment for chemistry classes based on the popular clamor of secondary schools to this effect. The teachers may have learned and developed the laboratory skills in their chemistry training courses but cannot teach the same to their students because of this material deficiency.

Precision instruments are undoubtedly expensive but their improvised model will be good enough for use in secondary schools chemistry classes. A significant portion, therefore, of the chemistry teacher training program should be alloted to improvisations of laboratory equipments which teachers can easily duplicate when they get back to their schools.

Relationship Between the Chemistry Teachers' Perceived Competencies and the Students' Perception of Their Learning

The coefficient of correlation between the teachers' perceived competencies in knowledge of the chemical concepts and laboratory skills and the corresponding students' perception of their extent of learning the concepts and skills were computed using the Pearson product-moment formula to determine if there exist a significant relationship between these two variables. The results are presented in the succeeding tables.

Table 14

Correlation Between Teachers' Knowledge and Students' Learning of Chemistry Concepts

Concepts	(TEA) X	(STDS) Y	X*X	Y*Y	X*Y
1. Electrochemical series	2.1	2.2	4.41	4.84	4.62
2. Buffers	2.1	2.5	4.41	6.25	5.25
3. Calculations at equilibrium	1.8	2.0	3.24	4.00	3.60
4. Molecular geometry	2.0	1.9	4.00	3.61	3.80
5. Carboxylic acids and esters	1.8	2.1	3.24	4.41	3.78
6. Properties of equilibrium constant	1.8	2.0	3.24	4.00	3.60
7. Alcohols, aldehydes and ketones	1.5	1.9	2.25	3.61	2.85
8. Breaking of colloids	1.7	2.0	2.89	4.00	3.40
9. Concept of pH	1.6	2.3	2.56	5.29	3.68
10. Reaction order	1.8	2.1	3.24	4.41	3.78
11. Colligative properties of solutions	1.7	2.0	2.89	4.00	3.40
12. Formation of colloids	1.5	1.9	2.25	3.61	2.85
13. Chemical equilibrium	1.6	1.9	2.56	3.61	3.04
14. Hydrocarbons	1.6	1.6	2.56	2.56	2.56
15. Polar and nonpolar molecules	1.7	1.9	2.89	3.61	3.23
16. Vapor pressure and relative humidity	1.6	2.1	2.56	4.41	3.36
17. Indicators	1.4	2.0	1.96	4.00	2.80
18. Properties of liquids: surface tension,viscosity	1.2	1.8	1.44	3.24	2.16
19. Calculations on concentrations of solutions	1.6	2.0	2.56	4.00	3.20
20. Hydrogen bonds	1.5	1.8	2.25	3.24	2.70
21. Specific heat and heat capacity	1.5	1.7	2.25	2.89	2.55
22. Carbohydrates, proteins, and fats	1.6	1.4	2.56	1.96	2.24
23. Oxidation-reduction reactions	1.5	1.8	2.25	3.24	2.70
24. Chemical bonds: ionic, covalent, metallic	1.4	1.8	1.96	3.24	2.52
25. Periodic properties of elements	1.2	1.4	1.44	1.96	1.68
26. Atomic size, electron affinity, ionization energy	1.4	1.8	1.96	3.24	2.52
27. Electronegativity	1.5	2.0	2.25	4.00	3.00
28. Factors affecting reaction rate	1.5	2.1	2.25	4.41	3.15
29. Conversion to SI units	1.2	1.8	1.44	3.24	2.16
30. Mole Concept	1.3	1.9	1.69	3.61	2.47
31. Chemical reactions and equations	1.2	1.7	1.44	2.89	2.04
32. Air pollution: causes and effects	1.2	1.5	1.44	2.25	1.80
33. Orbital concept of the atom	1.5	1.8	2.25	3.24	2.70
34. Calculations involving equations	1.4	2.0	1.96	4.00	2.80
35. Properties of colloids	1.4	1.9	1.96	3.61	2.66
36. Significant figure	1.1	1.7	1.21	2.89	1.87
37. Exponential numbers	1.2	1.7	1.44	2.89	2.04
38. Electron configuration	1.2	1.9	1.44	3.61	2.28

Table 14 (Continuation)

Concepts	(TEA) X	(STDS) Y	X*X	Y*Y	X*Y
39. Exothermic and endothermic reactions	1.2	1.8	1.44	3.24	2.16
40. Kinetic molecular theory	1.3	1.6	1.69	2.56	2.08
41. Calculations involving formulas	1.4	1.8	1.96	3.24	2.52
42. Nomenclature of compounds	1.4	2.0	1.96	4.00	2.80
43. Information from the periodic table	1.4	1.4	1.96	1.96	1.96
44. Properties of atoms	1.3	1.5	1.69	2.25	1.95
45. Scientific methods and applications	1.3	1.6	1.69	2.56	2.08
46. Salts	1.4	1.5	1.96	2.25	2.10
47. Atomic theory: Structure and properties of the atom	1.2	1.7	1.44	2.89	2.04
48. Formula writing	1.3	1.7	1.69	2.89	2.21
49. Acids and Bases	1.3	1.7	1.69	2.89	2.21
50. Metals and non-metals	1.2	1.5	1.44	2.25	1.80
51. Mixtures: Homogeneous and heterogeneous	1.2	1.4	1.44	1.96	1.68
52. Pure substances: elements and compounds	1.1	1.3	1.21	1.69	1.43
53. Classification of matter	1.2	1.3	1.44	1.69	1.56
54. Chemical change	1.1	1.3	1.21	1.69	1.43
55. Family of elements	1.3	1.6	1.69	2.56	2.08
56. Period of elements	1.3	1.5	1.69	2.25	1.95
57. Molar mass	1.4	1.8	1.96	3.24	2.52
58. Molar volume	1.4	1.9	1.96	3.61	2.66
59. Avogadro´s number	1.4	2.0	1.96	4.00	2.80
60. Electron theory	1.5	2.0	2.25	4.00	3.00
61. Quark theory	2.3	2.5	5.29	6.25	5.75
62. Isotopes	1.6	2.2	2.56	4.84	3.52
63. Radicals and polyatomic ions	1.6	2.1	2.56	4.41	3.36
64. Empirical formula	1.4	2.3	1.96	5.29	3.22
65. Molecular formula	1.3	1.8	1.69	3.24	2.34
66. Structural formula	1.4	2.0	1.96	4.00	2.80
67. Phase change and chemical change	1.2	1.6	1.44	2.56	1.92
68. Hydrolysis	1.5	1.9	2.25	3.61	2.85
69. Law of conservation of mass	1.3	1.6	1.69	2.56	2.08
70. Law of definite composition	1.2	1.8	1.44	3.24	2.16
71. Law of multiple proportion	1.4	2.0	1.96	4.00	2.80
72. Graham´s law of diffusion	1.5	2.1	2.25	4.41	3.15
73. Boyle´s law of volume-pressure relationship of gases	1.2	1.6	1.44	2.56	1.92
74. Charle´s law of volume-temperature relationship of ga	1.2	1.7	1.44	2.89	2.04
75. Avogadro´s principle	1.4	2.1	1.96	4.41	2.94
Totals	108.0	137.1	159.90	255.8	200.7

Table 14 shows the mean weighted ratings of the teachers' perceived competencies and the corresponding mean weighted ratings of the students' perception of their extent of learning each of the chemistry concepts. Their computed coefficient of correlation is 0.688. This denotes substantial relationship between these two variables (Garrett,1973). The critical value of r with 73 degrees of freedom and .05 level of significance is only 0.228.

On the other hand, Table 15 shows the mean weighted ratings of the teachers' perceived competencies and the corresponding mean weighted ratings of the students' perception of their extent of learning the laboratory skills included in this study. Their computed coefficient of correlation is 0.854, denoting high correlation between these two variables. The critical value of r with df = 49 in this case and .05 significance level is only 0.276.

Therefore, the null hypothesis that there is no significant relationship between the teachers' perception of their competencies in knowledge of concepts and laboratory skills to the students' perception of their extent of learning the concepts and skills is rejected at 0.05 level of significance.

The significant relationship between the two variables lends statistical support further to the researchers' assertion that it is imperative to identify the specific chemistry concepts and laboratory skills which either or

Table 15

Correlation Between Teacher's Competencies and Student's Extent of Learning the Laboratory Skills

SKILLS	(TEA) X	(STDS) Y	X*X	Y*Y	X*Y
1. Operate a spectrometer	2.3	2.6	5.29	6.76	5.98
2. Do column chromatography	2.2	2.7	4.84	7.29	5.94
3. Do thin layer chromatography	2.3	2.6	5.29	6.76	5.98
4. Use an autoclave	2.2	2.6	4.84	6.76	5.72
5. Do electrolysis	1.6	2.1	2.56	4.41	3.36
6. Collect gas by water displacement	1.5	2.0	2.25	4.00	3.00
7. Use pH paper	1.7	2.2	2.89	4.84	3.74
8. Identify terminal of galvanometer	1.9	2.5	3.61	6.25	4.75
9. Identify terminals of ammeter	2.0	2.5	4.00	6.25	5.00
10. Do refluxing	2.3	2.5	5.29	6.25	5.75
11. Do paper chromatography	2.0	2.5	4.00	6.25	5.00
12. Do pH determination	2.0	2.4	4.00	5.76	4.80
13. Use dessicator	2.1	2.5	4.41	6.25	5.25
14. Select proper indicator for titration	2.0	2.3	4.00	5.29	4.60
15. Calibrate volumetric instruments	1.8	2.2	3.24	4.84	3.96
16. Dispose acid/toxic waste	1.8	2.2	3.24	4.84	3.96
17. Use a centrifuge	1.7	2.2	2.89	4.84	3.74
18. Use a hydrometer	1.5	2.0	2.25	4.00	3.00
19. Select a substitute for a given chemical	1.8	2.2	3.24	4.84	3.96
20. Do ignition	1.8	2.4	3.24	5.76	4.32
21. Prepare solution of prescribed concentration	1.7	2.3	2.89	5.29	3.91
22. Use a pipette	1.5	2.4	2.25	5.76	3.60
23. Prepare capillary tubes	1.4	2.1	1.96	4.41	2.94
24. Heating in a test tube	1.2	1.4	1.44	1.96	1.68
25. Do titration	1.7	2.3	2.89	5.29	3.91
26. Prepare and use a burette	1.6	2.5	2.56	6.25	4.00
27. Use an analytical balance	1.6	2.0	2.56	4.00	3.20
28. Do crystallization	1.7	2.1	2.89	4.41	3.57
29. Use a separatory funnel	1.3	2.1	1.69	4.41	2.73
30. Do sublimation	1.3	2.2	1.69	4.84	2.86
31. Store and handle chemicals	1.4	2.0	1.96	4.00	2.80
32. Cut and bend glass tubings	1.4	2.1	1.96	4.41	2.94
33. Use an oven	1.5	2.0	2.25	4.00	3.00
34. Transfer liquids	1.3	1.7	1.69	2.89	2.21
35. Determine melting point	1.4	1.6	1.96	2.56	2.24
36. Use a cork borer	1.4	2.0	1.96	4.00	2.80
37. Do distillation	1.4	1.8	1.96	3.24	2.52
38. Regulate a bunsen burner	1.4	2.0	1.96	4.00	2.80

Table 15 (Continuation)

SKILLS	(TEA) X	(STDS) Y	X*X	Y*Y	X*Y
39. Determine boiling point	1.3	1.7	1.69	2.89	2.21
40. Weigh on a triple beam balance	1.3	2.0	1.69	4.00	2.60
41. Do filtration	1.3	1.9	1.69	3.61	2.47
42. Use a microscope	1.3	1.6	1.69	2.56	2.08
43. Prepare filter paper	1.2	1.8	1.44	3.24	2.16
44. Read a volume measuring device	1.3	1.8	1.69	3.24	2.34
45. Weigh on a platform balance	1.1	1.6	1.21	2.56	1.76
46. Read a thermometer	1.2	1.6	1.44	2.56	1.92
47. Graph data	1.3	1.7	1.69	2.89	2.21
48. Do simple dialysis	1.9	2.1	3.61	4.41	3.99
49. Read graph	1.4	1.9	1.96	3.61	2.66
50. Do electroplating	1.9	2.4	3.61	5.76	4.56
51. Use a calorimeter	1.9	2.4	3.61	5.76	4.56
Totals	83.1	108.3	140.91	235.05	181.04

both the teachers themselves claim to lack competency and the students perceive difficult to learn so that they may be provided for adequately in chemistry teachers training programs in order to make the training more responsive to the needs of these clientele.

Categorized List of Competencies

From Tables 14 and 15, and basing on the specified ranges of values against which the mean weighted ratings of the responses were interpreted descriptively, the concepts and skills were grouped into three categories.

The first category consists of those concepts and skills which teachers claim competency as well as students claim they learned easily. These are :

Concepts	Skills
Hydrocarbons	Heating in a test tube
Specific heat and heat capacity	Transfer liquids
Carbohydrates, proteins, and fats	Determine boiling point
Periodic properties of elements	Use a microscope
Chemical reactions and equations	Weigh on a platform balance
Air pollution; causes and effects	Read a thermometer
Significant figures	Graph data
Exponential numbers	
Kinetic molecular theory	
Information from the periodic table	
Properties of atoms	
Scientific methods and applications	
Salts	
Atomic theory	
Formula writing	
Acids and bases	
Matals and non-metals	
Mixtures	
Pure substances	
Classification of matters	
Chemical change	
Family of elements	
Phase change	
Period of elements	
Law of conservation of mass	
Boyle´ law	
Charle´s law	

The second category are those concepts and laboratory skills which teachers claim they lack competency which students also rated difficult to learn. They are :

Concepts	Skills
Electrochemical series	Operate a spectrometer
Buffers	Do column chromatography
Calculations of equilibrium	Do thin layer chromatography
Molecular geometry	Use an autoclave
Carboxylic acid and esters	

Properties of equilibrium constants
Reaction order
Quark theory

Identify terminals of ammeter
Do refluxing
Do paper chromatography
Use pH meter
Use dessicator
Select proper indicator for titration
Calibrate volumetric instrument
Dispose acid/toxic waste
Select substitute for a given chemical
Do ignition
Do simple dialysis
Do electroplating
Use a calorimeter

The third category are those concepts and skills which teachers feel competent but students either found difficult to learn or have never heard at all. These are:

Concepts	Skills
Alcohols, aldehydes, ketones	Do electrolysis
Breaking of colloids	Collect gas by water displacement
pH	Use pH paper
Colligative properties of solutions	Use a centrifuge
Formation of colloids	Use a hydrometer
Chemical equilibrium	Prepare solutions of prescribed concentration
Polar and nonpolar molecules	Use a pipette
Vapor pressure and relative humidity	Prepare capillary tubes
Indicators	Do titration
Properties of liquids; surface tension, viscosity	Prepare and use a burette
Calculations on concentration of solutions	Use an analytical balance
Hydrogen bonds	Do crystallization
Oxidation-reduction reactions	Use a separatory funnel
	Do sublimation
Chemical bonds; ionic, covalent, metallic	Store and handle chemicals
Atomic size, electron affinity, ionization energy	Cut and bend glass tubinge
Electronegativity	Use an oven
	Use a cork borer
	Do distillation
	Regulate a bunsen burner

Factors affecting reaction rate
Conversion to SI units
Mole concept
Orbital concept of the atom
Calculations involving equations
Properties of colloids
Electron configuration
Exothermic and endothermic reactions
Calculations involving formula
Nomenclature of compounds
Molar mass
Molar volume
Avogadro's number
Electron theory
Isotopes
Radicals and polyatomic ions
Empirical formula
Structural formula
Molecular formula
Hydrolysis
Law of definite composition
Law of multiple proportion
Graham's law of diffusion
Avogadro's principle

Weigh on a triple beam balance
Do filtration
Prepare filter paper
Read a volume measuring device
Read graph

The teachers' competencies in knowledge of chemistry concepts and laboratory skills thus categorized, the penultimate aim of the study to come up with explicit bases in planning a model for staff development of chemistry teachers is deemed achieved. Teamed with the findings about the teachers' competencies in teaching methods and assessment techniques used to teach and evaluate learning each major concept, respectively, the formulation of the model for staff development can be made even more precise to serve the need of the target clientele, i.e., the secondary schools chemistry teachers in Eastern Visayas and their students, within the proximate time frame.

Chapter 5

SUMMARY of FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter contains the summary of findings, conclusions, and recommendations of the study. A sample of the proposed model for staff development is subsumed under recommendations.

Summary of Findings

The findings of the study are herein presented vis-a-vis the specific questions and null hypotheses already stated.

Profile of Chemistry Teachers in Eastern Visayas.

The chemistry teachers in Eastern Visayas are all Bachelor's degree holder but most are non-chemistry major. Of the 40 teacher respondents only six are chemistry major and five are Bachelor of Science in Chemical Engineering; 14 are major in General Science, seven in Biology, two in Natural Science, and one each in Physical Science, Physics, and Filipino.

Thirteen of them have no chemistry unit at all. Of the 27 who have chemistry units, only 14 have advance chemistry courses.

Twenty three teachers have attended summer institutes that lasted from one to three summers; ten have attended workshops; 19 have attended seminars; and only three or two

have attended film fora and demonstration, respectively. Seven teachers have not attended any training at all; four of them being General Science major, one a Biology major and the other a Chemistry major.

Non-chemistry majors (mostly General Science and Biology) have been utilized to teach high school chemistry since more than 25 years ago. Sixteen out of 40 of the teacher respondents have been teaching chemistry within the past four years or less but of these only two are major in chemistry and two are B.S.Ch.E., the rest are non-chemistry major. Moreover, out of these 16 chemistry teachers ten have less than five years, and four have 5 -9 years total teaching experience.

Chemistry Teachers' Perception of Their Competencies.

The teachers are confident of their knowledge of 67 out of 75 specific chemistry concepts in the questionnaire-checklist. They, however, admitted lack of confidence in their knowledge of eight specific concepts such as carboxylic acids and esters, calculations at equilibrium, reaction order, properties of equilibrium constant, molecular geometry, buffers, electrochemical series, and quark theory.

The teachers perceive that they can perform proficiently 33 out of 51 laboratory skills listed in the questionnaire-checklist. The 18 laboratory skills which they feel they can perform but with apprehension are:

dispose acid/toxic waste, select a substitute for a given chemical, calibrate volumetric instrument, do ignition, identify terminals of a galvanometer, do simple dialysis, do electroplating, use a calorimeter, use a pH meter, do paper chromatography, select proper indicator for titration, identify terminals of ammeter, use dessicator, use an autoclave, do column chromatography, do thin layer chromatography, do refluxing, and operate a spectrometer.

The teachers are most familiar with and most often use lecture-demonstration method to teach practically all concepts. They are familiar with and most often use laboratory activity alongside with lecture-demonstration to teach 11 concepts . Although they are familiar with directed study and problem-solving methods they sparingly use these strategies in teaching the concepts. Teachers are familiar with and often use all four teaching methods in imparting laboratory skills but the most popular is laboratory activity.

The teachers find objective test the easiest technique in assessing students' learning of chemistry concepts although they feel inadequate in using it with eight concepts. They feel inadequate with other techniques as word association, performance test, concept mapping, prediction-observation-explanation, and Venn diagram in assessing students' learning of chemistry concepts. The only technique that the teachers find easy to use in

assessing students' proficiency in laboratory skills is performance test but only for common laboratory operatons; they feel inadequate with the technique to assess the other laboratory skills.

Chemistry Students' Perception About Their Extent and Facility of Learning the Chemical Concepts and Laboratory Skills.

Inspite of the teachers' claim of confidence in their knowledge of 67 out of 75 specific concepts, only 27 were perceived learned fully and easily by the students. Forty eight of the concepts were perceived by the students to have been learned only partially or learned with difficulty. They perceive that they have learned fully only eight laboratory skills, 39 skills just partially, and four of the skills they cannot perform at all.

Relationship Between the Chemistry Teachers' Perceived Competencies in Knowledge of Concepts With That of the Students' Perception of Their Facility of Learning Them

Using the Pearson product - moment correlation formula, a substantial relationship was found to exist between the teachers' perceived competencies in knowledge and the students' perception of their extent and facility of learning each of the chemistry concepts at .05 level of significance and df = 73.

Relationship Between the Chemistry Teachers' Perceived Proficiency in Laboratory Skills With That of the Students' Perception of Their Extent and Facility of Learning Them

A high correlation was found to exist between the teachers' perceived proficiency in laboratory skills and that of the students' perceived extent and facility of learning them also at .05 significance level and df = 49.

Conclusions

The following conclusions were inferred from the light of the findings presented in the preceding section:

1. In Eastern Visayas there is an acute shortage of chemistry teachers with appropriate educational qualifications and training;
2. The chemistry teachers are not fully confident of their knowledge of chemistry concepts particularly carboxylic acids and esters in organic chemistry, properties of equilibrium constant and calculations at equilibrium in chemical equilibra ; molecular geometry in covalent and hydrogen bonding; electrochemical series in electrochemistry; buffers in pH concept; and quark theory. They feel that they cannot perform proficiently laboratory operations such as dispose acid/toxic waste, select a substitute for a given chemical, calibrate volumetric instruments, do ignition, identify terminals of galvanometer, do simple

dialysis, do electroplating, use a calorimeter, use pH meter, do paper chromatography, select proper indicator for titration, identify terminals of ammeter, use dessicator, use an autoclave, do column chromatography, do thin layer chromatography, do refluxing, and operate a spectrometer.

3. The teachers feel competent with the four major teaching methods, namely: lecture-demonstration, laboratory activity, directed study, and problem-solving, but sparingly use the last two in teaching concepts;
4. Other than objective test to assess students' learning of concepts and performance test to assess students' proficiency in doing common laboratory operations, the teachers do not feel competent to use assessment techniques like essay, prediction-observation-explanation, Venn diagram, concept mapping, and word association.
5. There is significant relationship between the teachers' competencies and the students' extent and facility of learning the concepts and skills.
6. The large number of concepts and laboratory skills which the students had difficulty learning inspite of the teachers' "confidence" in their knowledge and skills thereof suggest other factors that significantly determine the teaching-learning effectiveness.

Recommendations

Based on the inferences derived from the findings of this study the following measures are hereby recommended to help improve competencies of chemistry teachers in Eastern Visayas:

1. Teacher training institutions in Region VIII with facilities and qualified faculty should:
   a) encourage more teacher trainees to major in chemistry teaching;
   b) offer incentives such as scholarships for deserving students who will major in chemistry teaching;
   c) undertake faculty development programs for chemistry teachers not in competition but in cooperation and coordination with the RSTC to accomodate more clientele.
2. The selection of participants to the training program should give priority to teachers teaching chemistry who are not chemistry major.
3. The training programs should progressively offer advance chemistry courses that will raise the teacher competencies in knowledge and laboratory skills beyond just the fundamentals in general chemistry.
4. Training programs should train participants in improvising set-up or models which can be used to

demonstrate or allow students to investigate principles on electrolysis, electroplating, calorimetry, simple dialysis, acid - base indicators, chromatography, distillation, and calibration of volumetric instruments using indigenous materials instead of relying on high precision instruments which local schools do not have.

5. Training in the different teaching strategies and assessment techniques should be equally emphasized as that of knowledge of concepts and proficiency in laboratory skills.

6. Chemistry teachers should be encouraged to join associations of chemistry teachers like the Philippine Association of Chemistry Teachers (PACT) and Organic Chemistry Teachers Association (OCTA) and pursue continuing education conducted by these associations to keep pace with recent discoveries and development as their impact to society and the environment affects trends in chemistry teaching.

7. Researches of this kind should be periodically conducted and probably improved for use as bases in planning future staff development programs.

8. Researches should be conducted to identify other factors aside form teachers' competencies that adversely affect teaching-learning effectiveness in chemistry education.

9. Training program content should be guided by findings of such studies in order to be more responsive to the particular needs of the teachers and students in the region as illustrated by the example presented in the succeeding sections.

10. Within the proximate time frame of this study, Chemistry teacher training programs for Region VIII should emphasize the following:

    10.1. Content, teaching strategies, and assessment techniques for concepts and skills which teachers claim they lack competence and students find difficult to learn (category 2, on page 88); and

    10.2. Teaching strategies and assessment techniques appropriate for concepts and skills which teachers feel competent with their knowledge and proficiency but students find difficult to learn (category 3, on page 89).

A Proposed Model for Staff Development of Chemistry Teachers in Region VIII

Introduction

The purpose of this proposal is to serve as a working paper for the envisioned teacher training program for high school chemistry teachers in Region VIII. This presentation

is not intended to be an exhaustive list of various techniques nor will it contain an in-depth or intensive treatment of the program. Rather, it is just an introduction and its main purpose is to stimulate and incite the interest of the authorities/people concerned to a viable method and technique of chemistry teacher training for pursuing in greater depth the chemistry concepts, laboratory skills, teaching methods, and assessment techniques actually needed by chemistry teachers in their teaching.

The Model

One of the basic assumptions in the proposed model illustrated in Figure 3 is that most of the chemistry concepts, laboratory skills, teaching methods, and assessment techniques, very much needed by chemistry teachers could easily be learned by them through exposure to four fundamental types of instruction during the training program. These four fundamental types of instruction are:

1.1. large-group instruction

1.2. small-group instruction

1.3. independent study, and

1.4. practicum.

The following example makes use of the four basic assumptions of the model and the findings of this study as inputs.

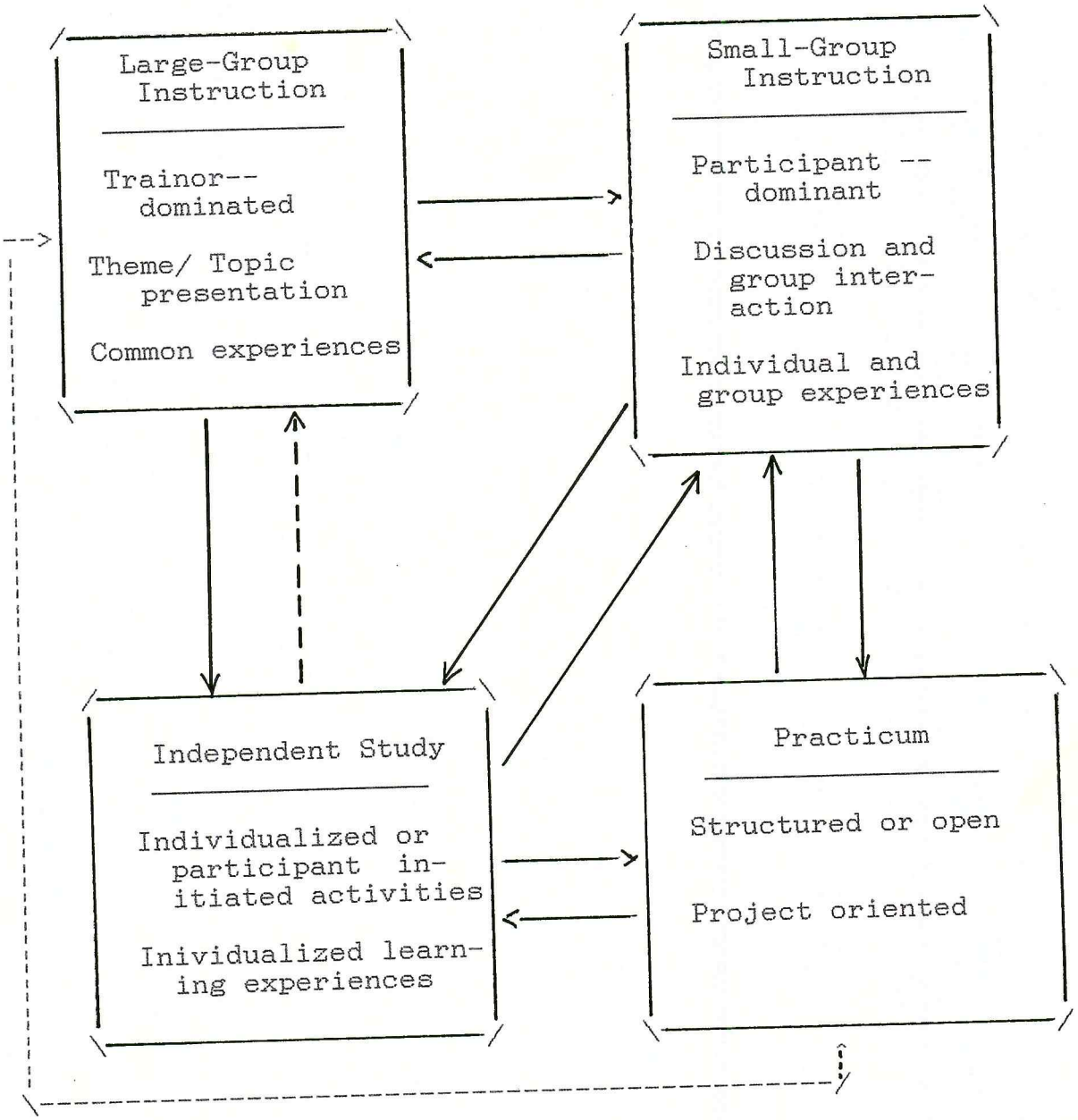

Fig. 3 . Basic Model of the Proposed Teacher Training Program

Rationale

In so far as the present study identified that the teachers in Eastern Visayas perceive themselves most inadequate in the various techniques other than objective test in assessing students' learning, and in so far as objective test may not be the most appropriate technique to assess students' learning of all the concepts and skills, and furthermore, that the unvariable use of objective test makes it so predictable and common that students may find testing a ritual and monotonous exercise, this model of a chemistry teacher training program focus in the development of teacher competency in assessment techniques other than objective test that will sustain enthusiasm of teachers and students throughout the course. These other techniques were found to yield more reliable measures of students' understanding at the same time as they bring to the surface students' misconceptions. Immediate remedial measures may then be instituted by the teacher to correct misconceptions revealed by the assessment technique. Provision for the development of teacher competencies in the use of these assessment techniques to evaluate students' learning of concepts and skills is, therefore, strongly recommended.

Objective

At the end of the training the teachers should be able to demonstrate the ability to use correctly each of the

following techniques to assess students' learning of a chemistry concept or laboratory skill:

1.1. Essay test

1.2. Objective test

1.3. Prediction-observation-explanation

1.4. Venn diagram

1.5. Concept mapping

1.6. Word association

1.7. Performance test

Large-group Instruction. Essentially, the large-group instruction is a trainor-dominated, teacher-lecture type activity. The size of the group is not important, however, due to psychological factors created by large-group, perhaps a 75 to 150 participants may suffice. In the large-group instruction each assessment technique is presented, discussed, and demonstrated by the trainor before all the participants. Each assessment technique may take up about two hours. Large-group instruction for this purpose then may take about two days. Independent study for those who can proceed to the next step independently or to small-group instruction for those who would prefer to interact with other participants first, follows.

Small-group Instruction. The basic premise of small group instruction is that, large-group instruction is trainor dominated and too little opportunity exists for

significant dialogue and interaction among the participants. For the most effective interaction and involvement of the participants, the group size should not be larger than 12 to 15 participants. The fundamental and characteristic event in the small group is discussion. Here, the participants through interaction and dialogue assume a dominant role, with guidance provided by the trainor/facilitator. Small-group instruction can be effectively employed for identifying the assessment technique appropriate for a particular chemistry concept or laboratory skill. The small group instruction develops an opportunity for genuine exchange of ideas relative to the task on hand among participants. Here, participants shall be allowed enough time to refer to books and references as positive measure towards clearer introspection into the whole chemistry course and help them identify the task they will undertake individually.

Independent Study. This type of instruction fills an extremely useful and necessary role in the model to provide greater degree of individualization to the participants. Independent study allows each participant to experience individualized learning activities and develop responsibility to prepare the materials and strategies he deems appropriate for his task. One day for this phase of the training is appropriate enough.

Practicum. The fourth type of instruction employed in this proposed training program is practicum. Essentially, in this part, the participants will have their first hand experience actually demonstrating the assessment technique he has prepared during independent study to a group of students or peer group.

A feedback mechanism will be appropriate to allow constructive criticisms and suggestions for improvement during the plenary session for it is not just doing the thing but doing it right that contribute to improvement.

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A P P E N D I C E S

Appendix A

Republic of the Philippines
Department of Education, Culture and Sports
REGIONAL OFFICE NO. VIII
Tacloban City

November 11, 1990
Date

To: All Secondary Schools Administrators
concerned:
Region VIII

Enclosed is a letter request of Mrs. Cosette C. Oliva, Ph.D. student, Samar State Polytechnic College, Catbalogan, Samar to conduct a survey study on the competencies of Secondary Schools Chemistry teachers.

Due to significant contributions which the educational system may derive from this study, it is requested that you extend to the researcher your usual support and cooperation to enable her to realize her goals.

Very truly yours,

ELADIO C. DIOKO, Ph.D.
Director IV

RECEIVED
RECORDS SECTION
11-12-90
DATE
Reg. VIII Tacloban City

ROS/sc3

Appendix B

REPUBLIC OF THE PHILIPPINES
SAMAR STATE POLYTECHNIC COLLEGE
CATBALOGAN, SAMAR

1st Indorsement
November 6, 1990

Respectfully forwarded to the Regional Director, Department of Education, Culture and Sports, Regional Office No. VIII, Tacloban City, the enclosed request of Mrs. Cosette C. Oliva, Associate Professor and Ph.D. candidate of this College, which is self-explanatory.

Considering that her research is of vital importance to the chemistry education of high school students and for staff development of chemistry teachers which are among the concerns of the Department, this study is hereby strongly indorsed for your favorable consideration.

SENECIO D. AYONG, Ed.D.,DPA
Dean, Graduate School

Appendix C

REPUBLIC OF THE PHILIPPINES
SAMAR STATE POLYTECHNIC COLLEGE
CATBALOGAN, SAMAR

November 6, 1990

The Regional Director
Department of Education, Culture and Sports
Regional Office No. VIII
Tacloban City

S i r :

I have the honor to request for your favorable indorsement to respondent schools of my questionnaire for my dissertation entitled, "Secondary Schools Chemistry Teachers' Competencies: Inputs to a Proposed Model for Staff Development".

Enclosed are the specific problems that will be addressed by the study, its significance, the proposed respondent schools, and copies of my instruments for your perusal.

I pray for your favorable consideration of my request.

Very truly yours,

Mrs. Cosette C. Oliva

MRS. COSETTE C. OLIVA
Ph. D. Student

Appendix D

REPUBLIC OF THE PHILIPPINES
SAMAR STATE POLYTECHNIC COLLEGE
CATBALOGAN, SAMAR

November 6, 1990

The School Administrator

S i r :

I have the honor to request permission to field in your school the questionnaire pertinent to my research entitled "Secondary Schools Chemistry Teachers' Competencies: Inputs to a Proposed Model for Staff Development".

Enclosed is a copy of the questionnaire which I intend to distribute to your chemistry teachers and samples of your fourth year students.

I will remain ever grateful for your kind accommodation of my herein request.

Very truly yours,

Mrs. Cosette C. Oliva

MRS. COSETTE C. OLIVA
Researcher

Appendix E

SURVEY QUESTIONNAIRE FOR SECONDARY SCHOOLS
CHEMISTRY TEACHERS' COMPETENCIES

TO THE RESPONDENT:

G r e e t i n g s !

You have been selected as a respondent in this research entitled "Secondary Schools Chemistry Teachers' Competencies: Inputs to a Proposed Model for Staff Development". The primary objective is to come up with a staff development training curriculum which is truly responsive to the needs of the secondary school chemistry teachers in Eastern Visayas. Your complete and honest response is therefore sincerely solicited. Rest assured your identity and that of your institution will be held strictly confidential. Only the modes and weighted averages of the responses will be treated and analyzed.

Thank you very much in anticipation of your cooperation for the good of the service.

The Researcher

Name (Optional)_____

Total number of years teaching _____

Number of years teaching High School Chemistry _____

Name of School/College/University _____

Address of School _____

Current Fourth Year enrolment of school _____

PREPARATORY QUALIFICATION

A. Please indicate the number of units or semester hours of chemistry and related subjects you have earned:

	Number of units/ Sem. hrs.
Advance Chemistry courses - - - - - -	
Physical Chemistry - - - - - - - - - -	
Organic Chemistry - - - - - - - - - - -	
Mathematics - - - - - - - - - - - - - -	
Physics - - - - - - - - - - - - - - - -	
General Chemistry - - - - - - - - - - -	

B. **Degree finished:** (Please check appropriate box.)

/__/ Science major (Pls. specify)_____

/__/ Non- Science major (Pls. specify)_____

C. **In-service training(s) attended:** (Please indicate the particulars needed).

Type of Training	Place/Sponsor	No. of hrs./ days duration
Summer Institute	_____	_____
Workshop(s)	_____	_____
Seminar(s)	_____	_____
Film Forum(s)	_____	_____
Demonstration(s)	_____	_____

COMPETENCIES IN TEACHING CONCEPTS AND SKILLS

A. Knowledge

Starting next page is a list of concepts and laboratory skills that the secondary students are supposed to learn from the secondary school chemistry course. Please rate honestly your knowledge of these concepts and your competence in performing the laboratory skills by checking the appropriate column, where:

A rating of **1** means you are confident of your knowledge of the concept/can perform the laboratory skill competently;
A rating of **2** means you are not fully confident of your knowledge of the concept/you perform the laboratory skill with apprehension;
A rating of **3** means that the concept/skill is completely unknown to you and you are afraid to teach it.

PLEASE ANSWER ALL ITEMS. IT IS ESSENTIAL FOR PROPER INTERPRETATION OF OVER-ALL RESPONSES

	CONCEPTS	Rating		
		1	2	3
1.	Electrochemical series			
2.	Buffers			
3.	Calculations at equilibrium			
4.	Molecular geometry			
5.	Carboxylic acids and esters			
6.	Properties of equilibrium constants			
7.	Alcohols, aldehydes and ketones			
8.	Breaking of colloids			
9.	Concept of pH			
10.	Reaction order			
11.	Colligative properties of solutions			
12.	Formation of colloids			
13.	Chemical equilibrium			
14.	Hydrocarbons			
15.	Polar and nonpolar molecules			
16.	Vapor pressure and relative humidity			
17.	Indicators			
18.	Properties of liquids			
19.	Calculations on concentrations of solutions			
20.	Hydrogen bonds			
21.	Specific heat and heat capacity			
22.	Carbohydrates, proteins, and fats			
23.	Oxidation-reduction reactions			
24.	Chemical bonds: ionic, covalent, metallic			
25.	Periodic properties of elements			
26.	Atomic size, electron affinity, ionization energy			
27.	Electronegativity			
28.	Factors affecting reaction rate			
29.	Conversion to SI units			
30.	Mole concept			
31.	Chemical reactions and equations			
32.	Air pollution: causes and effects			
33.	Orbital concept of the atom			
34.	Calculations involving equations			
35.	Properties of colloids			

	CONCEPTS	Rating 1	2	3
36.	Significant figure			
37.	Exponential numbers			
38.	Electron configuration			
39.	Exothermic and endothermic reactions			
40.	Kinetic molecular theory			
41.	Calculations involving formulas			
42.	Nomenclature of compounds			
43.	Information from the periodic table			
44.	Properties of atoms			
45.	Scientific methods and applications			
46.	Salts			
47.	Atomic theory			
48.	Formula writing			
49.	Acids and Bases			
50.	Metals and non-metals			
51.	Mixtures: Homogeneous and heterogeneous			
52.	Pure substances: elements and compounds			
53.	Classification of matter			
54.	Chemical change			
55.	Family of elements			
56.	Period of elements			
57.	Molar mass			
58.	Molar volume			
59.	Avogadro´s number			
60.	Electron theory			
61.	Quark theory			
62.	Isotopes			
63.	Radicals and polyatomic ions			
64.	Empirical formula			
65.	Molecular formula			
66.	Structural formula			
67.	Phase change and chemical change			
68.	Hydrolysis			
69.	Law of conservation of mass			
70.	Law of definite composition			
71.	Law of multiple proportion			
72.	Graham´s law of diffusion			
73.	Boyle´s law of volume-pressure relationship of gases			
74.	Charle´s law of volume-temperature relationship of gases			
75.	Avogadro´s principle			

SKILLS	Rating 1	2	3
1. Operate a spectrometer			
2. Do column chromatography			
3. Do thin layer chromatography			
4. Use an autoclave			
5. Do electrolysis			
6. Collect gas by water displacement			
7. Use pH paper			
8. Identify terminals of galvanometer			
9. Identify terminals of ammeter			
10. Do refluxing			
11. Do paper chromatography			
12. Use pH meter			
13. Use dessicator			
14. Select proper indicator for titration			
15. Calibrate volumetric instruments			
16. Dispose acid/toxic waste			
17. Use a centrifuge			
18. Use a hydrometer			
19. Select a substitute for a given chemical			
20. Do ignition			
21. Prepare solution of prescribed concentration			
22. Use a pipette			
23. Prepare capillary tubes			
24. Heating in a test tube			
25. Do titration			
26. Prepare and use a burette			
27. Use an analytical balance			
28. Do crystallization			
29. Use a separatory funnel			
30. Do sublimation			
31. Store and handle chemicals			
32. Cut and bend glass tubings			
33. Use an oven			
34. Transfer liquids			
35. Determine melting point			
36. Use a cork borer			
37. Do distillation			
38. Regulate a bunsen burner			
39. Determine boiling point			
40. Weigh on a beam balance			
41. Do filtration			
42. Use a microscope			
43. Prepare filter paper			
44. Read a volume measuring device			
45. Weigh on a platform balance			
46. Read a thermometer			
47. Graph data			
48. Do simple dialysis			
49. Read graph			
50. Do electroplating			
51. Use a calorimeter			

B. Use of Teaching Methods

Please rate honestly how well you can use the suggested teaching strategies for each concept/skill:

A rating of 1 means you are familiar with the method and use it often in teaching the concept/skill;

A rating of 2 means you are familiar with the method but use it sparingly in teaching the concept/skill;

A rating of 3 means you never use the method because you do not know how to use it for the specific concept/skill.

CONCEPTS	TEACHING METHODS				
	Lecture-Demonstration	Laboratory Activity	Directed Study	Problem-solving	others
1. Electrochemistry					
2. Chemical equilibra					
3. Organic compounds					
4. Colloids					
5. Electrolytes: acids, bases, salts					
6. Chemical bonds					
7. Kinetic molecular theory					
8. Thermochemistry					
9. Chemical reactions					
10. Atomic theory					
11. Periodicity of properties of elements					
12. Electron theory					
13. Measurements					
14. Stoichiometry					
15. Classification of matter					
16. Scientific method					
17. Chemical laws					
18. Chemical nomenclature					
19. Mole concept					

TEACHING METHODS

SKILLS	Lecture-Demonstration	Laboratory Activity	Directed Study	Problem-Solving	Others
1. Do spectrometry					
2. Do chromatography					
3. Do pH determination					
4. Sterilize					
5. Electrolyze					
6. Common laboratory operations					
7. Prepare solutions of specified concentration					
8. Titrate					
9. Weigh					
10. Glass manipulation					
11. Use volumetric instruments					
12. Read calibrated instruments					
13. Use electrical devices					
14. Do distillation					
15. Calibrate instruments					
16. Do simple dialysis					
17. Graph data					
18. Do calorimetry					

C. Use of Techniques to Assess Students' Learning

Please rate honestly your competency to use the following techniques in assessing students' learning in the different chemistry concepts/skills.

A rating of 1 means you use the technique with ease in evaluating students' learning of the concept/skill;

A rating of 2 means you feel inadequate in using the technique to evaluate students' learning of the concept/skill;

A rating of 3 means you are not familiar with the technique therefore cannot use it.

ASSESSMENT TECHNIQUES

CONCEPTS

		Essay	Short-answer Objective Test	Prediction-Observation-Explanation	Venn Diagram	Concept Mapping	Word Association	Performance Test	Others
1.	Electrochemistry								
2.	Chemical equilibra								
3.	Organic compounds								
4.	Colloids								
5.	Electrolytes: acids, bases, salts								
6.	Chemical bonds								
7.	Kinetic molecular theory								
8.	Thermochemistry								
9.	Chemical reactions								
10.	Atomic theory								
11.	Periodicity of properties of elements								
12.	Electron theory								
13.	Measurements								
14.	Stoichiometry								
15.	Classification of matter								
16.	Scientific method								
17.	Chemical laws								
18.	Chemical nomenclature								
19.	Mole concept								

SKILLS

		Essay	Short-answer Objective Test	Prediction-Observation-Explanation	Venn Diagram	Concept Mapping	Word Association	Performance Test	Others
1.	Do spectrometry								
2.	Do chromatography								
3.	Do pH determination								
4.	Sterilize								
5.	Electrolyze								
6.	Common laboratory operations								
7.	Prepare solutions of specified concentration								
8.	Titrate								
9.	Weigh								
10.	Glass manipulation								
11.	Use volumetric instruments								
12.	Read calibrated instruments								
13.	Use electrical devices								
14.	Do distillation								
15.	Calibrate instruments								
16.	Do simple dialysis								
17.	Graph data								
18.	Do calorimetry								

Appendix F

SURVEY QUESTIONNAIRE FOR
STUDENT RESPONDENTS

DEAR STUDENTS:

You have been selected as respondents in this research entitled " Secondary Schools Chemistry Teachers' Competencies: Inputs to a Proposed Model for Staff Development". Please reflect carefully and be honest with your self-assessment of the extent to which you have learned the concepts and developed the laboratory skills as a result of the instruction of your teacher in chemistry. You may choose not to write your name but please answer the subsequent data completely.

Thank you very much for your anticipated cooperation.

The Researcher

A. Name _____ Age _____ Sex _____

Name of School/College/University _____

Address of School _____

Present year level enrolment _____

Year passed high school chemistry subject _____

Final rating of high school chemistry subject _____

B. Inventory of Concepts Learned

Please rate honestly the extent to which you have learned the following concepts and skills. Use the coded rating below:

A rating of 1 means you learned the concept/skill fully and easily from your teacher;

A rating of 2 means you learned the concept/skill only partially from your teacher;

A rating of 3 means that you have no idea about the concept/skill at all.

	CONCEPTS	RATINGS		
		1	2	3
1.	Electrochemical series			
2.	Buffers			
3.	Calculations at equilibrium			
4.	Molecular geometry			
5.	Carboxylic acids and esters			
6.	Properties of equilibrium constant			
7.	Alcohols, aldehydes and ketones			
8.	Breaking of colloids			
9.	Concept of pH			
10.	Reaction order			
11.	Colligative properties of solutions			
12.	Formation of colloids			
13.	Chemical equilibrium			
14.	Hydrocarbons			
15.	Polar and nonpolar molecules			
16.	Vapor pressure and relative humidity			
17.	Indicators			
18.	Properties of liquids: surface tension, viscosity			
19.	Calculations on concentrations of solutions			
20.	Hydrogen bonds			
21.	Specific heat and heat capacity			
22.	Carbohydrates, proteins, and fats			
23.	Oxidation-reduction reactions			
24.	Chemical bonds: ionic, covalent, metallic			
25.	Periodic properties of elements			
26.	Atomic size, electron affinity, ionization energy			
27.	Electronegativity			
28.	Factors affecting reaction rate			
29.	Conversion to SI units			

	CONCEPTS	RATING		
		1	2	3
30.	Mole concept			
31.	Chemical reactions and equations			
32.	Air pollution: causes and effects			
33.	Orbital concept of the atom			
34.	Calculations involving equations			
35.	Properties of colloids			
36.	Significant figure			
37.	Exponential numbers			
38.	Electron configuration			
39.	Exothermic and endothermic reactions			
40.	Kinetic molecular theory			
41.	Calculations involving formulas			
42.	Nomenclature of compounds			
43.	Information from the periodic table			
44.	Properties of atoms			
45.	Scientific methods and applications			
46.	Salts			
47.	Atomic theory: Structure and properties of the atom			
48.	Formula writing			
49.	Acids and Bases			
50.	Metals and non-metals			
51.	Mixtures: Homogeneous and heterogeneous			
52.	Pure substances: elements and compounds			
53.	Classification of matter			
54.	Chemical change			
55.	Family of elements			
56.	Period of elements			
57.	Molar mass			
58.	Molar volume			
59.	Avogadro's number			
60.	Electron theory			
61.	Quark theory			
62.	Isotopes			
63.	Radicals and polyatomic ions			
64.	Empirical formula			
65.	Molecular formula			
66.	Structural formula			
67.	Phase change and chemical change			
68.	Hydrolysis			
69.	Law of conservation of mass			
70.	Law of definite composition			
71.	Law of multiple proportion			
72.	Graham's law of diffusion			
73.	Boyle's law of volume-pressure relationship of gases			
74.	Charle's law of volume-temperature relationship of gases			
75.	Avogadro's principle			

	SKILLS	RATINGS 1	2	3
1.	Operate a spectrometer			
2.	Do column chromatography			
3.	Do thin layer chromatography			
4.	Use an autoclave			
5.	Do electrolysis			
6.	Collect gas by water displacement			
7.	Use pH paper			
8.	Identify terminals of galvanometer			
9.	Identify terminals of ammeter			
10.	Do refluxing			
11.	Do paper chromatography			
12.	Use pH meter			
13.	Use dessicator			
14.	Select proper indicator for titration			
15.	Calibrate volumetric instruments			
16.	Dispose acid/toxic waste			
17.	Use a centrifuge			
18.	Use a hydrometer			
19.	Select a substitute for a given chemical			
20.	Do ignition			
21.	Prepare solution of prescribed concentration			
22.	Use a pipette			
23.	Prepare capillary tubes			
24.	Heating in a test tube			
25.	Do titration			
26.	Prepare and use a burette			
27.	Use an analytical balance			
28.	Do crystallization			
29.	Use a separatory funnel			
30.	Do sublimation			
31.	Store and handle chemicals			
32.	Cut and bend glass tubings			
33.	Use an oven			
34.	Transfer liquids			
35.	Determine melting point			
36.	Use a cork borer			
37.	Do distillation			
38.	Regulate a bunsen burner			
39.	Determine boiling point			
40.	Weigh on a triple beam balance			
41.	Do filtration			
42.	Use a microscope			
43.	Prepare filter paper			
44.	Read a volume measuring device			
45.	Weigh on a platform balance			
46.	Read a thermometer			
47.	Graph data			
48.	Do simple dialysis			
49.	Read graph			
50.	Do electroplating			
51.	Use a calorimeter			

Appendix G

TEACHERS' PROFILE

Tea.Resp. No.	Total Yrs Tea. Exp.	No.of Yrs Tea.Chem.	Degree finished /Major	Non-science Major	Chemistry Units Earned Adv. Chem.	Phys. Chem.	Org. Chem.	Gen. Chem.	Total	In-Service Trainings Attended Type of Training	Place/Sponsor	Duration
1	16	10		FILIPINO					0	Sum Institute Workshop Seminar	DWUT-EDPITAF Biliran-NSDB Calbayog City-NSDB	3 Summers 40 hours 24 hours
2	10	5	BIOLOGY			5	5	5	15	Sum Institute Workshop Seminar	DWUT-NSTA/IPMD/DOST SSPC-NSTA SSPC-SNS-NSTA	2 Summers 64 HOURS 64 hours
3	3	3	BSChE,Math,Physics			10	10	8	28	Seminar	USC-DOST	1 month
4	9	9	BS BIOLOGY		12		8	10	30			
5	16	16	CHEMISTRY		12	5	10	10	37	Sum Institute	DWUT-NSDB	40 days
6	17	1							0	Sum Institute	DWUT-NSDB	40 days
7	6	5	PHYSICAL SCIENCE		6	9	9	6	30	Sum Institute Workshop Seminar	LSC Carigara-DOST SEDP	1 summer 1 week 28 days
8	3	1	NATURAL SCIENCE			10	5	3	18	Workshop Seminar Demonstration	USC Cagayan de Oro Cebu-RVM	36 hours 40 hours 8 hours
9	2	2	GENERAL SCIENCE		10		5	10	25	Workshop Seminar	Ateneo-CEAP Maryknoll-CEAP	4 days 1 day

Tea. Resp. No.	Total Tea. Exp.	Yrs No. of Tea. Chem.	Degree finished /Major	Non-science Major	Chemistry Units Earned Adv. Chem.	Phys. Chem.	Org. Chem.	Gen. Chem.	Total	In-Service Trainings Attended Type of Training	Place/Sponsor	Duration
10	18	15	GENERAL SCIENCE		5	5	5	10	25	Sum Institute Workshop Seminar Film Forum	Baguio UPLB-DOST DWUT-DOST Maasin	45 days 2 weeks 2 days 1/2 day
11	6	6	GENERAL SCIENCE				5	5	10	Workshop Seminar	Maasin-SOLPRISA Palo-SEDP	3 days 5 days
12	2	2					5	5	10			
13	8	6	BSChE		16	4	9	6	35	Sum Institute	Tacloban-NSTA	135 days
14	15	15	GENERAL SCIENCE			3	3	10	16	Sum Institute	UP/DWUT	10 weeks
15	14	14							0	Sum Institute	DWUT/NSTA	45 days
16	20	20	BS CHEMISTRY						0	Sum Institute		186 hours
17	27	20	GENERAL SCIENCE						0	Sum Institute	Siliman-RSTC	2 summers
18	20	15	GENERAL SCIENCE						0	Sum Institute Seminar	DWUT-NSTA DWUT-NSTA	3 Summers 186 hours
19	28	20	GEN. SC., CHEM.						0			
20	3	2	CHEM, PHYSICS		15	5	10	10	40	Sum Institute	DWUT	2 months

Appendix G (Continuation)

Tea.Resp. No.	Total Tea. Exp.	Yrs No.of Tea.Chem.	Degree finished /Major	Non-science Major	Chemistry Units Earned Adv. Chem.	Phys. Chem.	Org. Chem.	Gen. Chem.	Total	In-Service Trainings Attended Type of Training	Place/Sponsor	Duration
21	10	10	CHEM., BIOLOGY			8	12	12	32	Sum Institute Seminar	DWUT-DOST SSPC-PACT	180 hours 72 hours
22	3	1	NATURAL SCIENCE						0	Seminar	SEDP	30 days
23	3	1	GENERAL SCIENCE					10	10			
24	3	2	BSCHE			8	10	10	28	Workshop Seminar	Carigara-DECS/DOST SSPC-PACT	3 days 3 days
25	2	1	CHEMISTRY		16	3	10	10	39			
26	4	4	CHEMISTRY		3	3	9	6	21	Seminar Seminar	SSPC-PACT SEDP	3 days 28 days
27	5	4	BIOLOGY		18	9	3	3	33	Sum Institute Seminar	DWUT-DOST PACT	2 summer 5 days
28	21	5	BSCHE			11	10	12	33	Sum Institute Seminar	Aquinas University PACT	44 days 5 days
29	9	4	BIOLOGY		10		5	5	20	Sum Institute	DWUT-NSDB	1 summer
30	8	5	GEN. SC. . BIOLOGY				10	5	15	Film Forum	NSDB	every Sat for 1 year
31	20	20	BIOLOGY, PHYSICS			3	3	4	10	Sum Institute	DWUT-NSTA	1 summer

Appendix G (Continuation)

Tea.Resp. No.	Total Yrs Tea. Exp.	No.of Yrs Tea.Chem.	Degree finished /Major	Non-science Major	Chemistry Units Earned Adv. Chem.	Phys. Chem.	Org. Chem.	Gen. Chem.	Total	In-Service Trainings Attended Type of Training	Place/Sponsor	Duration
32	7	6	BIOLOGY						0	Sum Institute Fellowship	DWUT Australia	72 hours 9 months
33	16	13	GENERAL SCIENCE						0	Sum Institute Workshop Film Forum Demonstration	Siliman/DWUT Siliman Univ Siliman Univ Siliman Univ	2 summers 1 summer
34	6	6	CHEMISTRY		12	6	12	6	36	Sum Institute Workshop	NSTA EDPITAF	45 days 2 weeks
35	15	15	GENERAL SCIENCE						0			
36	26	1	BIOLOGY	ENGLISH					0	Sum Institute Seminar	DWUT Baguio	2 months 1 month
37	12	8	BSChE			11	10	12	33	Seminar	SEDP	1 month
38	6	2	GENERAL SCIENCE						0	Sum Institute	DWUT	1 summer
39	11	10	GENERAL SCIENCE		6	5	5	5	21	Seminar	SEDP	28 days
40	6	4	GENERAL SCIENCE		15	5	5	5	30			

Appendix H

Teachers' Competencies in the Use of Teaching Methods to Impart Concepts

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respondents
CONCEPT 1 Electrochemistry							
Lect-Demo	18	16	5	39	1.7	1	40
Lab Activity	16	16	6	38	1.7	2	40
Directed Study	9	16	12	37	2.1	3	40
Problem Solving	11	16	11	38	2.0	2	40
CONCEPT 2 Chemical Equilibra							
Lect-Demo	22	14	4	40	1.6	0	40
Lab Activity	14	13	12	39	1.9	1	40
Directed Study	13	14	11	38	1.9	2	40
Problem Solving	16	12	11	39	1.9	1	40
CONCEPT 3 Organic Compounds							
Lect-Demo	26	10	4	40	1.5	0	40
Lab Activity	14	17	5	36	1.8	4	40
Directed Study	13	15	10	38	1.9	2	40
Problem Solving	12	14	12	38	2.0	2	40
CONCEPT 4 Colloids							
Lect-Demo	25	7	5	37	1.5	3	40
Lab Activity	23	14	3	40	1.5	0	40
Directed Study	12	14	12	38	2.0	2	40
Problem Solving	10	17	10	37	2.0	3	40
CONCEPT 5 Electrolytes: acids, bases, salts							
Lect-Demo	20	13	5	38	1.6	2	40
Lab Activity	23	13	4	40	1.5	0	40
Directed Study	14	14	7	35	1.8	5	40
Problem Solving	10	17	10	37	2.0	3	40
CONCEPT 6 Chemical bonds							
Lect-Demo	25	13	2	40	1.4	0	40
Lab Activity	13	16	8	37	1.9	3	40
Directed Study	13	14	11	38	1.9	2	40
Problem Solving	10	19	8	37	1.9	3	40
CONCEPT 7 Kinetic molecular theory							
Lect-Demo	25	11	3	39	1.4	1	40
Lab Activity	19	13	6	38	1.7	2	40
Directed Study	17	12	10	39	1.8	1	40
Problem Solving	15	11	12	38	1.9	2	40
CONCEPT 8 Thermochemistry							
Lect-Demo	17	15	6	38	1.7	2	40
Lab Activity	14	15	10	39	1.9	1	40
Directed Study	12	11	15	38	2.1	2	40
Problem Solving	13	13	14	40	2.0	0	40

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respondents
CONCEPT 9 Chemical reactions							
Lect-Demo	27	10	3	40	1.4	0	40
Lab Activity	19	15	5	39	1.6	1	40
Directed Study	13	14	10	37	1.9	3	40
Problem Solving	17	14	7	38	1.7	2	40
CONCEPT 10 Atomic theory							
Lect-Demo	30	7	3	40	1.3	0	40
Lab Activity	17	13	7	37	1.7	3	40
Directed Study	15	13	8	36	1.8	4	40
Problem Solving	13	14	11	38	1.9	2	40
CONCEPT 11 Periodicity of properties of elements							
Lect-Demo	26	11	3	40	1.4	0	40
Lab Activity	13	17	6	36	1.8	4	40
Directed Study	15	16	7	38	1.8	2	40
Problem Solving	17	13	8	38	1.8	2	40
CONCEPT 12 Electron theory							
Lect-Demo	23	13	4	40	1.5	0	40
Lab Activity	13	16	8	37	1.9	3	40
Directed Study	12	16	10	38	1.9	2	40
Problem Solving	12	17	8	37	1.9	3	40

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respondents
CONCEPT 13 Measurements							
Lect-Demo	12	17	8	37	1.9	3	40
Lab Activity	23	9	7	39	1.6	1	40
Directed Study	25	10	5	40	1.5	0	40
Problem Solving	24	11	5	40	1.5	0	40
CONCEPT 14 Stoichiometry							
Lect-Demo	19	13	7	39	1.7	1	40
Lab Activity	12	14	13	39	2.0	1	40
Directed Study	14	11	15	40	2.0	0	40
Problem Solving	13	12	14	39	2.0	1	40
CONCEPT 15 Classification of matter							
Lect-Demo	25	9	6	40	1.5	0	40
Lab Activity	25	10	5	40	1.5	0	40
Directed Study	21	10	7	38	1.6	2	40
Problem Solving	19	12	8	39	1.7	1	40
CONCEPT 16 Scientific method							
Lect-Demo	27	7	6	40	1.5	0	40
Lab Activity	25	9	6	40	1.5	0	40
Directed Study	19	11	8	38	1.7	2	40
Problem Solving	21	12	7	40	1.7	0	40

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respondents
CONCEPT 17 Chemical laws							
Lect-Demo	24	8	7	39	1.6	1	40
Lab Activity	24	12	4	40	1.5	0	40
Directed Study	17	12	9	38	1.8	2	40
Problem Solving	21	13	6	40	1.6	0	40
CONCEPT 18 Chemical nomenclature							
Lect-Demo	27	8	5	40	1.5	0	40
Lab Activity	21	9	8	38	1.7	2	40
Directed Study	17	14	7	38	1.7	2	40
Problem Solving	14	14	11	39	1.9	1	40
CONCEPT 19 Mole concept							
Lect-Demo	28	6	6	40	1.5	0	40
Lab Activity	11	16	11	38	2.0	2	40
Directed Study	9	19	12	40	2.1	0	40
Problem Solving	14	13	11	38	1.9	2	40

Appendix I

Teachers' Competencies in the Use of Teaching Methods to Impart Skills

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respond-ents
SKILL 1 Do spectrometry							
Lect-Demo	8	24	6	38	1.9	2	40
Lab Activity	12	15	12	39	2.0	1	40
Directed Study	9	23	6	38	1.9	2	40
Problem Solving	12	18	6	36	1.8	4	40
SKILL 2 Do chromatography							
Lect-Demo	8	18	10	36	2.1	4	40
Lab Activity	13	20	4	37	1.8	3	40
Directed Study	12	20	5	37	1.8	3	40
Problem Solving	13	15	10	38	1.9	2	40
SKILL 3 Do pH determination							
Lect-Demo	12	21	4	37	1.8	3	40
Lab Activity	15	18	5	38	1.7	2	40
Directed Study	12	19	9	40	1.9	0	40
Problem Solving	15	20	4	39	1.7	1	40
SKILL 4 Sterilize							
Lect-Demo	20	14	4	38	1.6	2	40
Lab Activity	23	12	3	38	1.5	2	40
Directed Study	19	9	9	37	1.7	3	40
Problem Solving	8	22	7	37	2.0	3	40
SKILL 5 Electrolyze							
Lect-Demo	23	12	3	38	1.5	2	40
Lab Activity	18	19	3	40	1.6	0	40
Directed Study	13	23	2	38	1.7	2	40
Problem Solving	9	22	7	38	1.9	2	40
SKILL 6 Do common laboratory operations							
Lect-Demo	16	19	5	40	1.7	0	40
Lab Activity	26	9	5	40	1.5	0	40
Directed Study	10	24	3	37	1.8	3	40
Problem Solving	23	8	7	38	1.6	2	40
SKILL 7 Prepare solutions of specified concentration							
Lect-Demo	25	12	1	38	1.4	2	40
Lab Activity	20	18	2	40	1.6	0	40
Directed Study	11	19	7	37	1.9	3	40
Problem Solving	11	23	4	38	1.8	2	40
SKILL 8 Titrate							
Lect-Demo	21	10	6	37	1.6	3	40
Lab Activity	17	18	4	39	1.7	1	40
Directed Study	7	24	8	39	2.0	1	40
Problem Solving	14	23	2	39	1.7	1	40

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respond-ents
SKILL 9 Weigh							
Lect-Demo	24	12	2	38	1.4	2	40
Lab Activity	29	9	1	39	1.3	1	40
Directed Study	22	10	6	38	1.6	2	40
Problem Solving	21	15	3	39	1.5	1	40
SKILL 10 Glass manipulation							
Lect-Demo	25	12	1	38	1.4	2	40
Lab Activity	24	15	1	40	1.4	0	40
Directed Study	25	8	4	37	1.4	3	40
Problem Solving	23	8	6	37	1.5	3	40
SKILL 11 Use volumetric instruments							
Lect-Demo	17	12	9	38	1.8	2	40
Lab Activity	24	12	4	40	1.5	0	40
Directed Study	23	12	4	39	1.5	1	40
Problem Solving	24	7	7	38	1.6	2	40
SKILL 12 Read calibrated instruments							
Lect-Demo	21	10	7	38	1.6	2	40
Lab Activity	25	10	4	39	1.5	1	40
Directed Study	25	10	2	37	1.4	3	40
Problem Solving	21	9	7	37	1.6	3	40

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respond-ents
SKILL 13 Use electrical devices							
Lect-Demo	12	20	5	37	1.8	3	40
Lab Activity	19	19	2	40	1.6	0	40
Directed Study	14	22	3	39	1.7	1	40
Problem Solving	16	19	3	38	1.7	2	40
SKILL 14 Do distillation							
Lect-Demo	22	12	4	38	1.5	2	40
Lab Activity	28	8	2	38	1.3	2	40
Directed Study	24	11	3	38	1.4	2	40
Problem Solving	23	2	13	38	1.7	2	40
SKILL 15 Calibrate instruments							
Lect-Demo	24	12	1	37	1.4	3	40
Lab Activity	26	12	2	40	1.4	0	40
Directed Study	13	19	5	37	1.8	3	40
Problem Solving	19	12	8	39	1.7	1	40
SKILL 16 Do simple dialysis							
Lect-Demo	15	19	3	37	1.7	3	40
Lab Activity	14	20	4	38	1.7	2	40
Directed Study	8	20	9	37	2.0	3	40
Problem Solving	12	19	9	40	1.9	0	40

Teaching Methods	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	Total Respondents
SKILL 17 Graph data							
Lect-Demo	24	16	0	40	1.4	0	40
Lab Activity	24	14	1	39	1.4	1	40
Directed Study	21	9	7	37	1.6	3	40
Problem Solving	22	9	7	38	1.6	2	40
SKILL 18 Do calorimetry							
Lect-Demo	6	23	8	37	2.1	3	40
Lab Activity	14	23	3	40	1.7	0	40
Directed Study	2	21	15	38	2.3	2	40
Problem Solving	10	22	6	38	1.9	2	40

Appendix J

Teachers' Competencies in Using Assessment Techniques to Assess Students' Learning of Concepts

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 1 Electrochemistry							
ESSAY	8	22	9	39	2.0	1	40
OBJECTIVE TEST	19	12	7	38	1.7	2	40
P O E	8	13	19	40	2.3	0	40
VENN DIAGRAM	0	9	29	38	2.8	2	40
CONCEPT MAPPING	5	7	26	38	2.6	2	40
WORD ASSOCIATION	7	16	15	38	2.2	2	40
PERFORMANCE TEST	13	18	7	38	1.8	2	40
CONCEPT 2 Chemical equilibra							
ESSAY	10	17	10	37	2.0	3	40
OBJECTIVE TEST	17	15	8	40	1.8	0	40
P O E	7	18	13	38	2.2	2	40
VENN DIAGRAM	2	19	17	38	2.4	2	40
CONCEPT MAPPING	7	20	13	40	2.2	0	40
WORD ASSOCIATION	8	13	16	37	2.2	3	40
PERFORMANCE TEST	11	11	16	38	2.1	2	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 3 Organic compounds							
ESSAY	12	17	8	37	1.9	3	40
OBJECTIVE TEST	18	16	6	40	1.7	0	40
P O E	16	5	18	39	2.1	1	40
VENN DIAGRAM	1	17	19	37	2.5	3	40
CONCEPT MAPPING	6	16	17	39	2.3	1	40
WORD ASSOCIATION	8	14	16	38	2.2	2	40
PERFORMANCE TEST	14	12	13	39	2.0	1	40
CONCEPT 4 Colloids							
ESSAY	15	10	12	37	1.9	3	40
OBJECTIVE TEST	18	8	11	37	1.8	3	40
P O E	14	13	12	39	1.9	1	40
VENN DIAGRAM	2	12	22	36	2.6	4	40
CONCEPT MAPPING	7	14	16	37	2.2	3	40
WORD ASSOCIATION	10	11	17	38	2.2	2	40
PERFORMANCE TEST	15	11	14	40	2.0	0	40

Appendix J (Continuation)

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 5 Electrolytes: Acids, Bases & Salts							
ESSAY	10	13	15	38	2.1	2	40
OBJECTIVE TEST	19	8	12	39	1.8	1	40
P O E	12	15	13	40	2.0	0	40
VENN DIAGRAM	0	15	22	37	2.6	3	40
CONCEPT MAPPING	7	14	18	39	2.3	1	40
WORD ASSOCIATION	11	9	17	37	2.2	3	40
PERFORMANCE TEST	16	11	13	40	1.9	0	40
CONCEPT 6 Chemical bonds							
ESSAY	11	11	16	38	2.1	2	40
OBJECTIVE TEST	22	11	7	40	1.6	0	40
P O E	9	11	18	38	2.2	2	40
VENN DIAGRAM	2	12	24	38	2.6	2	40
CONCEPT MAPPING	6	15	18	39	2.3	1	40
WORD ASSOCIATION	7	15	17	39	2.3	1	40
PERFORMANCE TEST	16	12	12	40	1.9	0	40
CONCEPT 7 Kinetic Molecular Theory							
ESSAY	18	7	12	37	1.8	3	40
OBJECTIVE TEST	21	8	10	39	1.7	1	40
P O E	16	12	12	40	1.9	0	40
VENN DIAGRAM	1	12	24	37	2.6	3	40
CONCEPT MAPPING	10	13	15	38	2.1	2	40
WORD ASSOCIATION	7	14	17	38	2.3	2	40
PERFORMANCE TEST	13	11	14	38	2.0	2	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 8 Thermochemistry							
ESSAY	13	9	15	37	2.1	3	40
OBJECTIVE TEST	15	11	12	38	1.9	2	40
P O E	13	12	15	40	2.1	0	40
VENN DIAGRAM	1	13	24	38	2.6	2	40
CONCEPT MAPPING	6	17	15	38	2.2	2	40
WORD ASSOCIATION	9	12	16	37	2.2	3	40
PERFORMANCE TEST	14	10	14	38	2.0	2	40
CONCEPT 9 Chemical Reactions							
ESSAY	11	10	17	38	2.2	2	40
OBJECTIVE TEST	19	9	10	38	1.8	2	40
P O E	18	11	11	40	1.8	0	40
VENN DIAGRAM	1	14	22	37	2.6	3	40
CONCEPT MAPPING	4	19	15	38	2.3	2	40
WORD ASSOCIATION	6	14	18	38	2.3	2	40
PERFORMANCE TEST	13	14	13	40	2.0	0	40
CONCEPT 10 Atomic Theory							
ESSAY	16	10	12	38	1.9	2	40
OBJECTIVE TEST	21	9	9	39	1.7	1	40
P O E	13	10	17	40	2.1	0	40
VENN DIAGRAM	2	13	22	37	2.5	3	40
CONCEPT MAPPING	7	12	18	37	2.3	3	40
WORD ASSOCIATION	7	12	17	36	2.3	4	40
PERFORMANCE TEST	13	10	14	37	2.0	3	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 11 Periodicity of Properties of Elements							
ESSAY	12	10	15	37	2.1	3	40
OBJECTIVE TEST	21	9	9	39	1.7	1	40
P O E	13	9	18	40	2.1	0	40
VENN DIAGRAM	2	13	22	37	2.5	3	40
CONCEPT MAPPING	7	12	18	37	2.3	3	40
WORD ASSOCIATION	9	12	17	38	2.2	2	40
PERFORMANCE TEST	13	10	14	37	2.0	3	40
CONCEPT 12 Electron Theory							
ESSAY	13	12	12	37	2.0	3	40
OBJECTIVE TEST	18	10	10	38	1.8	2	40
P O E	11	11	18	40	2.2	0	40
VENN DIAGRAM	0	12	25	37	2.7	3	40
CONCEPT MAPPING	8	12	18	38	2.3	2	40
WORD ASSOCIATION	10	10	18	38	2.2	2	40
PERFORMANCE TEST	13	9	16	38	2.1	2	40
CONCEPT 13 Measurements							
ESSAY	11	12	14	37	2.1	3	40
OBJECTIVE TEST	20	9	11	40	1.8	0	40
P O E	10	14	14	38	2.1	2	40
VENN DIAGRAM	3	14	20	37	2.5	3	40
CONCEPT MAPPING	9	13	16	38	2.2	2	40
WORD ASSOCIATION	9	13	16	38	2.2	2	40
PERFORMANCE TEST	19	11	10	40	1.8	0	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 14 Stoichiometry							
ESSAY	8	11	18	37	2.3	3	40
OBJECTIVE TEST	15	10	13	38	1.9	2	40
P O E	7	13	17	37	2.3	3	40
VENN DIAGRAM	3	13	23	39	2.5	1	40
CONCEPT MAPPING	4	15	19	38	2.4	2	40
WORD ASSOCIATION	6	12	20	38	2.4	2	40
PERFORMANCE TEST	12	10	17	39	2.1	1	40
CONCEPT 15 Classification of Matter							
ESSAY	17	10	12	39	1.9	1	40
OBJECTIVE TEST	23	7	10	40	1.7	0	40
P O E	20	6	13	39	1.8	1	40
VENN DIAGRAM	2	14	21	37	2.5	3	40
CONCEPT MAPPING	11	13	14	38	2.1	2	40
WORD ASSOCIATION	10	14	14	38	2.1	2	40
PERFORMANCE TEST	15	10	15	40	2.0	0	40
CONCEPT 16 Scientific Method							
ESSAY	21	8	10	39	1.7	1	40
OBJECTIVE TEST	23	7	10	40	1.7	0	40
P O E	18	7	14	39	1.9	1	40
VENN DIAGRAM	5	11	21	37	2.4	3	40
CONCEPT MAPPING	11	12	16	39	2.1	1	40
WORD ASSOCIATION	10	13	15	38	2.1	2	40
PERFORMANCE TEST	18	7	13	38	1.9	2	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 17 Chemical Laws							
ESSAY	14	10	15	39	2.0	1	40
OBJECTIVE TEST	24	7	8	39	1.6	1	40
P O E	20	9	10	39	1.7	1	40
VENN DIAGRAM	4	12	21	37	2.5	3	40
CONCEPT MAPPING	9	12	16	37	2.2	3	40
WORD ASSOCIATION	10	10	18	38	2.2	2	40
PERFORMANCE TEST	15	9	14	38	2.0	2	40
CONCEPT 18 Chemical Nomenclature							
ESSAY	12	14	13	39	2.0	1	40
OBJECTIVE TEST	23	7	8	38	1.6	2	40
P O E	10	14	14	38	2.1	2	40
VENN DIAGRAM	4	13	20	37	2.4	3	40
CONCEPT MAPPING	5	15	18	38	2.3	2	40
WORD ASSOCIATION	10	12	17	39	2.2	1	40
PERFORMANCE TEST	11	10	16	37	2.1	3	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
CONCEPT 19 Mole Concept							
ESSAY	15	10	12	37	1.9	3	40
OBJECTIVE TEST	23	7	8	38	1.6	2	40
P O E	10	13	15	38	2.1	2	40
VENN DIAGRAM	4	12	21	37	2.5	3	40
CONCEPT MAPPING	6	16	15	37	2.2	3	40
WORD ASSOCIATION	10	14	16	40	2.2	0	40
PERFORMANCE TEST	14	11	13	38	2.0	2	40

Appendix K

Teachers' Competencies in Using Assessment Techniques to Assess Laboratory Skills Developed by Students

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 1 Do Spectrometry							
ESSAY	5	11	22	38	2.4	2	40
OBJECTIVE TEST	4	12	21	37	2.5	3	40
P O E	6	10	22	38	2.4	2	40
VENN DIAGRAM	0	12	25	37	2.7	3	40
CONCEPT MAPPING	3	10	25	38	2.6	2	40
WORD ASSOCIATION	3	12	23	38	2.5	2	40
PERFORMANCE TEST	7	12	21	40	2.4	0	40
SKILL 2 Do Chromatography							
ESSAY	4	12	21	37	2.5	3	40
OBJECTIVE TEST	7	12	20	39	2.3	1	40
P O E	7	12	20	39	2.3	1	40
VENN DIAGRAM	1	10	26	37	2.7	3	40
CONCEPT MAPPING	4	12	21	37	2.5	3	40
WORD ASSOCIATION	4	12	22	38	2.5	2	40
PERFORMANCE TEST	13	10	17	40	2.1	0	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 3 Do pH determination							
ESSAY	7	12	19	38	2.3	2	40
OBJECTIVE TEST	10	10	17	37	2.2	3	40
P O E	9	12	18	39	2.2	1	40
VENN DIAGRAM	3	13	23	39	2.5	1	40
CONCEPT MAPPING	3	14	20	37	2.5	3	40
WORD ASSOCIATION	3	14	20	37	2.5	3	40
PERFORMANCE TEST	12	13	15	40	2.1	0	40
SKILL 4 Sterilize							
ESSAY	9	11	18	38	2.2	2	40
OBJECTIVE TEST	9	12	17	38	2.2	2	40
P O E	10	10	18	38	2.2	2	40
VENN DIAGRAM	5	13	21	39	2.4	1	40
CONCEPT MAPPING	6	12	19	37	2.4	3	40
WORD ASSOCIATION	5	14	19	38	2.4	2	40
PERFORMANCE TEST	15	12	13	40	2.0	0	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 5 Electrolyze							
ESSAY	12	12	15	39	2.1	1	40
OBJECTIVE TEST	15	10	12	37	1.9	3	40
P O E	12	10	16	38	2.1	2	40
VENN DIAGRAM	4	14	20	38	2.4	2	40
CONCEPT MAPPING	5	15	17	37	2.3	3	40
WORD ASSOCIATION	4	15	19	38	2.4	2	40
PERFORMANCE TEST	15	15	10	40	1.9	0	40
SKILL 6 Common laboratory operations							
ESSAY	13	11	14	38	2.0	2	40
OBJECTIVE TEST	17	9	14	40	1.9	0	40
P O E	17	9	14	40	1.9	0	40
VENN DIAGRAM	6	12	20	38	2.4	2	40
CONCEPT MAPPING	10	10	17	37	2.2	3	40
WORD ASSOCIATION	10	11	17	38	2.2	2	40
PERFORMANCE TEST	22	8	10	40	1.7	0	40
SKILL 7 Prepare solutions of specified concentration							
ESSAY	10	11	17	38	2.2	2	40
OBJECTIVE TEST	11	14	13	38	2.1	2	40
P O E	14	9	14	37	2.0	3	40
VENN DIAGRAM	5	12	21	38	2.4	2	40
CONCEPT MAPPING	6	15	16	37	2.3	3	40
WORD ASSOCIATION	7	12	18	37	2.3	3	40
PERFORMANCE TEST	16	14	9	39	1.8	1	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 8 Titrate							
ESSAY	11	9	18	38	2.2	2	40
OBJECTIVE TEST	12	10	17	39	2.1	1	40
P O E	10	10	17	37	2.2	3	40
VENN DIAGRAM	4	13	21	38	2.4	2	40
CONCEPT MAPPING	4	13	20	37	2.4	3	40
WORD ASSOCIATION	7	11	20	38	2.3	2	40
PERFORMANCE TEST	13	13	13	39	2.0	1	40
SKILL 9 Weigh							
ESSAY	12	9	16	37	2.1	3	40
OBJECTIVE TEST	17	8	14	39	1.9	1	40
P O E	13	9	15	37	2.1	3	40
VENN DIAGRAM	6	12	20	38	2.4	2	40
CONCEPT MAPPING	8	12	17	37	2.2	3	40
WORD ASSOCIATION	12	7	19	38	2.2	2	40
PERFORMANCE TEST	19	11	10	40	1.8	0	40
SKILL 10 Glass manipulation							
ESSAY	10	10	18	38	2.2	2	40
OBJECTIVE TEST	16	8	14	38	1.9	2	40
P O E	12	9	16	37	2.1	3	40
VENN DIAGRAM	5	11	22	38	2.4	2	40
CONCEPT MAPPING	7	11	19	37	2.3	3	40
WORD ASSOCIATION	10	7	20	37	2.3	3	40
PERFORMANCE TEST	18	11	11	40	1.8	0	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 11 Use volumetric instruments							
ESSAY	12	8	18	38	2.2	2	40
OBJECTIVE TEST	13	11	15	39	2.1	1	40
P O E	12	9	16	37	2.1	3	40
VENN DIAGRAM	6	10	22	38	2.4	2	40
CONCEPT MAPPING	6	12	20	38	2.4	2	40
WORD ASSOCIATION	6	11	20	37	2.4	3	40
PERFORMANCE TEST	18	11	11	40	1.8	0	40
SKILL 12 Read calibrated instruments							
ESSAY	12	10	16	38	2.1	2	40
OBJECTIVE TEST	14	10	14	38	2.0	2	40
P O E	12	11	15	38	2.1	2	40
VENN DIAGRAM	6	10	22	38	2.4	2	40
CONCEPT MAPPING	6	13	19	38	2.3	2	40
WORD ASSOCIATION	9	11	18	38	2.2	2	40
PERFORMANCE TEST	17	13	10	40	1.8	0	40
SKILL 13 Use electrical devices							
ESSAY	10	11	17	38	2.2	2	40
OBJECTIVE TEST	10	13	16	39	2.2	1	40
P O E	7	14	16	37	2.2	3	40
VENN DIAGRAM	4	14	20	38	2.4	2	40
CONCEPT MAPPING	3	17	18	38	2.4	2	40
WORD ASSOCIATION	6	12	19	37	2.4	3	40
PERFORMANCE TEST	14	16	10	40	1.9	0	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 14 Do distillation							
ESSAY	11	10	17	38	2.2	2	40
OBJECTIVE TEST	15	10	13	38	1.9	2	40
P O E	10	12	15	37	2.1	3	40
VENN DIAGRAM	5	14	19	38	2.4	2	40
CONCEPT MAPPING	4	15	19	38	2.4	2	40
WORD ASSOCIATION	8	10	19	37	2.3	3	40
PERFORMANCE TEST	19	11	10	40	1.8	0	40
SKILL 15 Calibrate instruments							
ESSAY	9	12	17	38	2.2	2	40
OBJECTIVE TEST	13	10	16	39	2.1	1	40
P O E	12	10	15	37	2.1	3	40
VENN DIAGRAM	4	16	18	38	2.4	2	40
CONCEPT MAPPING	4	9	11	24	2.3	16	40
WORD ASSOCIATION	6	7	12	25	2.2	15	40
PERFORMANCE TEST	13	12	7	32	1.8	8	40
SKILL 16 Do simple dialysis							
ESSAY	5	14	19	38	2.4	2	40
OBJECTIVE TEST	8	13	18	39	2.3	1	40
P O E	6	13	18	37	2.3	3	40
VENN DIAGRAM	4	15	20	39	2.4	1	40
CONCEPT MAPPING	3	15	20	38	2.4	2	40
WORD ASSOCIATION	3	14	20	37	2.5	3	40
PERFORMANCE TEST	10	12	18	40	2.2	0	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 17 Graph data							
ESSAY	11	10	17	38	2.2	2	40
OBJECTIVE TEST	16	7	15	38	2.0	2	40
P O E	11	14	13	38	2.1	2	40
VENN DIAGRAM	7	13	19	39	2.3	1	40
CONCEPT MAPPING	6	16	16	38	2.3	2	40
WORD ASSOCIATION	8	12	17	37	2.2	3	40
PERFORMANCE TEST	17	12	11	40	1.9	0	40

Assessment Techniques	No. of 1 Ans.	No. of 2 Ans.	No. of 3 Ans.	Total No. of Resp.	Weighted Mean of Responses	No Answer	No. of Respondents
SKILL 18 Do calorimetry							
ESSAY	8	12	18	38	2.3	2	40
OBJECTIVE TEST	11	11	17	39	2.2	1	40
P O E	5	15	18	38	2.3	2	40
VENN DIAGRAM	5	14	20	39	2.4	1	40
CONCEPT MAPPING	2	16	20	38	2.5	2	40
WORD ASSOCIATION	5	14	20	39	2.4	1	40
PERFORMANCE TEST	12	14	14	40	2.1	0	40

Appendix L

Students' Ratings of Their Extent of Learning the Chemical Concepts

Student Resp. No.	School	Type of School	Average Age (Yrs.)	Fourth Year Enrolment	No. of Samples	% of samples	Concept No. ------> 1	2	3	4	5	6	7	8	9
1- 35	SJC	P	16.0	353	35	10	2.3	2.6	1.8	1.6	2.1	1.6	2.0	1.8	2.3
36- 60	SLSAT	V	16.6	142	25	18	2.2	2.8	2.0	2.1	2.0	1.9	1.8	1.6	2.5
61- 81	CNSAT	V	16.4	137	21	15	2.0	2.5	2.3	1.7	1.6	2.1	1.5	1.8	2.3
82- 93	BNAC	V	17.8	115	12	10	1.5	1.8	1.8	1.5	1.2	1.5	1.3	1.4	1.8
94-207	LNHS	G	16.1	1139	114	10	2.2	2.5	2.0	1.9	2.2	1.8	1.9	1.7	2.3
208-252	WLC	P	17.4	231	45	19	2.8	2.8	2.1	2.2	2.5	2.2	2.3	2.0	2.6
253-271	LCTC	P	16.6	113	19	17	2.8	2.8	2.4	2.3	2.5	2.3	2.4	2.8	2.7
272-292	LNTS	V	16.3	215	21	10	2.1	2.4	2.0	2.0	1.6	1.9	1.6	2.3	1.6
293-325	BNVS	V	16.4	191	33	17	2.5	2.7	2.4	2.0	2.5	2.5	2.3	2.4	2.7
326-341	TTMIST	V	16.8	106	16	15	2.6	2.9	2.1	2.3	2.6	2.4	2.1	2.8	2.8
342-364	FAMSAT	V	15.2	227	23	10	2.9	3.0	3.0	2.7	2.9	3.0	2.7	2.7	2.8
365-405	DNHS	G	16.4	393	41	10	2.6	2.6	2.1	2.1	2.3	2.1	2.2	2.1	2.3
406-480	SNS	G	16.1	785	75	10	2.4	2.6	2.3	2.1	2.4	2.5	1.9	2.1	2.5
481-491	VMHS	G	16.6	87	11	13	1.3	1.8	1.2	1.2	1.4	1.3	1.0	1.3	1.7
492-591	AHS	G	17.0	825	100	12	2.2	2.2	1.9	1.7	1.9	2.2	1.9	1.9	1.9
TOTALS				5059	591										
AVERAGE			16.517926			12									
Mean Weighted Ratings/Concepts							2.2	2.5	2.0	1.9	2.1	2.0	1.9	2.0	2.3

Appendix L (Continuation)

Concept No ------>

Student Resp. No.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1- 35	2.0	2.1	1.9	1.6	1.5	1.9	1.8	1.5	1.5	2.0	1.5	1.4	1.2	1.4	1.4	1.3	1.5	1.4	1.9	2.1	1.5	1.4	1.3
36- 60	2.1	1.8	1.5	1.5	1.4	2.2	2.1	1.7	1.8	2.2	1.8	1.5	1.3	1.6	1.7	1.1	1.9	2.0	2.2	1.3	1.7	1.6	1.1
61- 81	2.3	1.8	1.7	2.2	1.4	2.0	1.7	2.3	2.1	2.0	1.6	1.3	1.1	1.6	1.6	1.2	1.3	1.3	1.8	1.3	1.7	1.7	1.4
82- 93	1.6	1.3	1.3	1.4	1.0	1.1	1.5	1.8	1.7	1.6	1.5	1.8	1.4	1.3	1.4	1.2	1.7	1.3	1.8	1.3	1.5	1.5	1.3
94-207	2.2	2.0	1.8	2.0	2.0	2.0	2.2	2.1	1.9	1.9	2.0	1.8	1.6	2.0	2.0	1.4	1.9	2.0	2.0	1.9	1.8	1.8	1.2
208-252	2.4	2.0	2.0	2.1	2.2	2.2	2.2	2.4	2.1	2.3	2.0	1.9	1.7	2.2	2.4	2.1	2.4	2.6	2.6	2.4	2.6	2.3	2.0
253-271	2.7	2.5	2.8	2.5	2.2	2.6	2.6	2.8	2.2	2.4	2.3	1.9	1.2	1.9	2.0	1.5	2.3	2.7	2.6	2.8	2.6	1.7	2.1
272-292	2.3	2.4	2.1	1.9	1.4	2.4	2.4	1.8	2.3	2.1	1.4	1.8	1.2	2.1	1.9	1.6	1.9	2.2	2.4	1.7	2.1	1.5	1.3
293-325	2.5	2.2	2.1	1.9	1.8	1.8	2.4	2.3	1.9	2.2	1.8	2.0	1.7	1.9	1.8	1.7	2.1	2.2	2.5	2.0	2.0	1.8	1.8
326-341	2.4	2.4	2.8	2.2	1.3	1.2	2.0	2.1	1.5	1.8	1.3	2.0	1.8	1.8	1.1	1.1	1.4	1.6	2.0	2.1	1.6	1.5	2.1
342-364	2.9	2.7	2.8	2.8	2.9	2.7	2.9	2.5	2.6	2.5	2.8	2.8	1.9	2.7	2.8	1.7	2.9	2.9	3.0	2.4	2.7	2.7	2.5
365-405	2.1	2.2	2.0	1.7	1.9	2.1	2.0	2.1	1.7	2.2	2.3	1.7	1.6	2.0	2.1	1.6	2.1	2.4	2.3	2.0	2.1	1.9	1.5
406-480	2.3	2.0	1.8	2.3	1.9	2.2	2.1	1.6	1.9	2.0	2.1	1.4	1.5	2.0	1.9	1.6	2.2	2.4	2.1	1.5	1.8	1.7	1.4
481-491	1.4	1.6	1.2	1.0	1.0	1.2	1.7	1.5	1.3	2.0	1.3	1.3	1.1	1.2	1.4	1.0	1.2	1.4	1.5	1.4	1.1	1.1	1.2
492-591	1.9	2.1	2.0	1.8	1.4	1.8	2.1	1.9	1.9	1.8	1.8	1.7	1.4	1.5	1.8	1.4	1.8	2.0	1.9	1.9	1.8	1.7	1.4
TOTALS																							
AVERAGE Mean Weighted Ratings/Co	2.1	2.0	1.9	1.9	1.6	1.9	2.1	2.0	1.8	2.0	1.8	1.7	1.4	1.8	1.8	1.4	1.8	2.0	2.1	1.8	1.9	1.7	1.5

Appendix L (Continuation)

Concept No. ------>

Student Resp. No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
1- 35	1.4	2.0	1.7	1.6	1.3	1.3	1.2	1.4	1.6	1.9	1.1	1.3	1.4	1.3	1.5	1.2	1.2	1.3	1.3	1.3	1.1	1.2	1.3
36- 60	1.3	2.0	1.3	1.5	1.4	1.5	1.4	1.5	1.8	2.0	1.2	1.2	1.7	1.6	1.6	1.8	1.4	1.1	1.2	1.2	1.4	1.3	2.0
61- 81	1.4	2.0	1.5	1.6	1.8	1.7	1.5	1.7	2.1	2.0	1.2	1.4	1.8	1.2	1.5	1.6	1.6	1.3	1.2	1.3	1.4	1.3	1.5
82- 93	1.6	1.8	1.5	1.6	1.7	1.6	2.4	1.7	1.6	1.5	1.2	1.1	1.2	1.3	1.4	1.8	1.8	1.3	1.2	1.2	1.2	1.1	1.0
94-207	1.8	1.9	1.6	1.5	1.4	1.8	1.8	1.8	1.8	2.2	1.5	1.7	1.7	1.7	2.0	1.8	1.9	1.7	1.4	1.4	1.6	1.5	1.5
208-252	2.2	2.2	2.2	2.3	2.2	2.6	2.4	2.0	2.2	2.4	1.8	1.8	1.9	2.0	1.9	2.1	2.3	2.0	2.2	2.2	1.7	1.9	2.3
253-271	2.2	2.6	2.6	2.1	1.9	2.4	2.1	1.6	2.2	2.4	1.6	1.7	1.9	2.0	1.9	2.2	2.7	1.4	1.8	1.4	1.3	1.3	1.9
272-292	1.8	2.0	2.1	1.3	1.4	1.9	2.1	1.8	1.8	1.8	1.6	1.6	1.7	1.7	1.8	1.5	1.7	1.9	1.7	1.5	1.5	1.7	1.9
293-325	2.1	2.4	2.1	2.2	2.2	2.5	2.0	2.0	2.1	2.3	1.6	1.7	1.7	1.7	1.9	2.1	2.1	1.6	1.5	1.4	1.5	1.4	1.6
326-341	1.8	1.6	2.7	1.8	1.7	1.7	2.6	1.6	1.7	2.5	1.4	1.4	1.4	1.1	1.4	1.2	1.1	1.3	1.1	1.4	1.0	1.3	1.3
342-364	2.6	2.7	2.5	2.4	2.3	2.7	2.2	2.2	2.3	2.7	2.2	2.3	2.5	1.7	2.7	2.3	1.4	2.0	1.5	1.6	1.7	1.9	2.4
365-405	2.0	1.9	2.0	2.0	1.8	2.1	1.8	1.5	1.9	2.0	1.7	1.6	1.9	1.7	1.8	1.9	2.0	1.6	1.3	1.3	1.4	1.4	1.8
406-480	1.9	1.9	1.8	1.7	1.5	2.3	1.8	1.7	1.9	2.3	1.6	1.5	1.5	1.5	1.8	1.7	1.8	1.4	1.3	1.3	1.4	1.4	1.9
481-491	1.2	1.6	1.2	1.0	1.5	1.1	1.3	1.2	1.5	1.6	1.2	1.2	1.1	1.1	1.1	1.2	1.2	1.0	1.1	1.1	1.0	1.0	1.3
492-591	2.0	1.8	1.8	1.8	1.7	1.9	1.9	1.6	1.7	1.6	1.4	1.3	1.6	1.4	1.4	1.4	1.5	1.6	1.7	1.4	1.4	1.2	1.5
TOTALS																							
AVERAGE Mean Weighted Ratings/Col	1.8	2.0	1.9	1.7	1.7	1.9	1.8	1.6	1.8	2.0	1.4	1.5	1.6	1.5	1.7	1.7	1.7	1.5	1.4	1.3	1.3	1.3	1.6

Appendix L (Continuation)

Concept No. ---->

Student Resp. No.	School	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
1- 35	SJC	1.3	1.5	1.6	1.6	1.6	2.4	1.4	1.8	1.8	1.4	1.8	1.3	1.9	1.2	1.3	1.4	1.9	1.8	1.7	1.5
36- 60	SLSAT	1.7	1.3	1.5	1.6	1.8	2.5	2.6	1.7	2.3	1.5	2.0	1.3	1.8	1.3	1.3	1.7	2.0	1.4	1.4	1.8
61- 81	CNSAT	1.3	1.5	1.5	1.4	1.9	2.4	1.6	2.0	2.4	1.9	2.0	1.2	1.8	1.3	1.6	2.0	1.9	1.3	1.4	1.7
82- 93	BNAC	1.3	1.4	1.6	1.8	1.8	2.2	1.8	1.8	2.4	1.8	1.7	1.3	1.6	1.3	1.5	2.2	2.5	1.2	1.6	1.8
94-207	LNHS	1.4	1.9	2.0	2.0	2.3	2.5	2.6	2.4	2.4	2.0	2.0	1.6	1.9	1.7	1.9	2.1	2.0	1.6	1.8	2.1
208-252	WLC	2.2	2.2	2.1	2.4	2.4	2.7	2.8	2.6	2.4	2.1	2.3	2.2	2.3	2.0	2.0	2.3	2.4	2.2	2.1	2.4
253-271	LCTC	1.8	2.6	2.7	2.8	2.2	2.7	2.5	2.6	2.8	2.2	2.3	1.8	2.7	2.1	2.4	2.6	2.5	2.6	2.5	2.5
272-292	LNTS	1.5	2.4	2.2	2.6	2.1	2.7	2.4	2.2	2.3	1.9	1.8	1.8	1.9	1.6	1.9	2.1	2.1	1.4	2.1	2.5
293-325	BNVS	1.8	1.6	1.7	1.9	2.3	2.4	2.7	2.3	2.2	1.8	2.0	2.0	1.9	1.9	1.8	2.0	2.0	1.4	1.6	2.0
326-341	TTMIST	1.2	1.5	1.8	2.6	2.0	2.8	2.6	2.2	2.4	1.5	1.4	1.6	1.6	1.4	2.3	2.4	2.4	1.3	1.6	2.8
342-364	FAMSAT	2.2	2.8	2.9	2.9	2.9	3.0	3.0	2.9	3.0	2.9	2.9	2.6	2.9	2.8	2.8	3.0	2.7	2.0	2.1	3.0
365-405	DNHS	1.9	2.2	2.3	2.4	2.3	2.6	2.4	2.3	2.3	2.0	2.2	1.8	2.2	1.8	1.9	2.0	1.8	1.5	1.5	2.3
406-480	SNS	1.6	1.6	2.0	1.9	2.2	2.7	2.5	2.7	2.7	1.9	2.3	1.6	2.1	1.6	1.8	2.1	2.2	1.6	1.6	2.1
481-491	VMHS	1.2	1.5	1.6	1.5	1.4	1.7	1.4	1.3	1.5	1.5	1.5	1.2	1.6	1.2	1.3	1.5	1.5	1.2	1.3	1.5
492-591	AHS	1.5	1.8	2.0	2.1	1.6	2.2	2.0	2.0	2.2	1.7	1.7	1.7	1.6	1.4	1.6	1.6	2.1	2.1	2.1	2.1
TOTALS																					
AVERAGE Mean Weighted Ratings/Concepts		1.5	1.8	1.9	2.0	2.0	2.5	2.2	2.1	2.3	1.8	2.0	1.6	1.9	1.6	1.8	2.0	2.1	1.6	1.7	2.1

Appendix M

Students' Ratings of Their Extent of Learning the Laboratory Skills

Laboratory Skills ----->

Student Resp. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1- 35	2.5	2.7	2.7	2.6	2.2	2.1	2.1	2.5	2.4	2.4	2.4	2.3	2.4	1.9	1.9	1.7	1.7	1.7	1.8	1.9	1.8	2.2	2.1	1.1	2.2
36- 60	2.6	2.7	2.7	2.8	1.8	1.8	2.1	2.5	2.4	2.5	2.5	2.3	2.3	2.2	2.2	2.2	2.1	2.0	2.2	2.2	2.4	2.4	1.8	1.1	2.4
61- 81	2.8	2.8	2.7	2.9	2.3	2.2	2.4	2.5	2.6	2.8	2.6	2.7	2.8	2.7	2.6	2.6	2.7	2.2	2.2	2.6	2.3	2.8	2.3	1.5	2.7
82- 93	2.6	2.8	2.8	2.5	1.7	1.4	1.6	2.3	2.4	2.3	2.3	1.8	2.0	2.0	1.7	1.7	1.9	1.4	1.8	2.3	1.8	2.4	1.7	1.3	2.2
94-207	2.7	2.7	2.7	2.8	2.2	2.0	2.3	2.4	2.5	2.6	2.7	2.6	2.6	2.3	2.3	2.1	2.3	2.1	2.2	2.3	2.1	2.2	2.1	1.5	2.2
208-252	2.8	2.9	2.8	2.8	2.6	2.3	2.5	2.6	2.6	2.7	2.7	2.6	2.8	2.6	2.3	2.5	2.5	2.2	2.3	2.7	2.7	2.8	2.2	2.0	2.6
253-271	2.8	3.0	2.8	2.9	2.8	2.3	2.7	2.9	2.9	2.9	2.9	2.8	2.8	2.7	2.5	2.7	2.6	2.5	2.7	2.8	2.6	2.8	2.1	1.7	2.6
272-292	2.4	2.6	2.4	2.4	1.9	2.1	1.9	2.5	2.4	2.5	2.5	2.4	2.2	2.4	2.1	2.1	1.9	1.9	2.4	2.5	2.5	2.6	2.4	1.3	2.5
293-325	2.6	2.9	2.9	2.9	2.6	2.4	2.5	2.7	2.8	2.7	2.6	2.7	2.6	2.5	2.4	2.4	2.5	2.3	2.5	2.6	2.4	2.5	2.1	1.6	2.4
326-341	2.9	2.9	2.9	2.9	1.8	2.4	2.8	2.9	2.8	2.9	2.9	2.9	3.0	2.7	2.9	2.3	2.4	2.2	2.6	2.8	2.5	2.3	2.4	1.1	2.7
342-364	3.0	3.0	3.0	3.0	3.0	2.8	2.6	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	3.0	2.8	2.9	3.0	2.9	3.0	2.6	2.0	2.9
365-405	2.7	2.7	2.7	2.6	2.6	2.2	2.5	2.7	2.7	2.7	2.7	2.5	2.7	2.5	2.3	2.3	2.4	2.1	2.0	2.5	2.2	2.5	2.4	1.8	2.5
406-480	2.6	2.8	2.7	2.8	2.3	1.9	2.6	2.6	2.7	2.7	2.7	2.6	2.6	2.5	2.6	2.4	2.5	2.3	2.4	2.5	2.5	2.5	2.3	1.3	2.4
481-491	2.1	2.2	2.1	1.8	1.3	1.4	1.5	1.7	2.0	1.7	1.6	1.5	1.7	1.5	1.4	1.3	1.7	1.3	1.4	1.8	1.7	1.8	1.7	1.2	1.6
492-591	2.5	2.6	2.4	2.6	1.9	1.8	2.0	2.4	2.2	2.4	2.2	2.2	2.3	2.2	2.2	2.1	2.0	1.8	2.1	2.1	2.2	2.2	2.0	1.6	2.2
TOTALS																									
Mean Weighted Rtg/Skill	2.6	2.7	2.6	2.6	2.1	2.0	2.2	2.5	2.5	2.5	2.5	2.4	2.5	2.3	2.2	2.2	2.2	2.0	2.2	2.4	2.3	2.4	2.1	1.4	2.3

Appendix M (Continuation)

Laboratory Skills ---->

Student Resp. No.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
1- 35	2.3	2.0	2.0	1.9	1.7	1.8	2.0	1.6	1.4	1.3	1.9	1.5	2.0	1.3	1.6	1.9	1.6	1.8	1.6	1.3	1.2	1.3	1.7	1.7	2.1	1.9
36- 60	2.6	2.1	2.3	2.0	2.3	2.1	2.2	2.0	1.6	1.3	2.1	1.3	2.1	1.8	1.8	1.3	1.5	1.5	1.9	1.6	1.5	1.6	2.2	1.9	2.6	2.7
61- 81	2.7	2.0	2.1	2.0	2.6	2.2	2.0	2.3	2.0	1.5	2.0	1.7	2.3	1.9	2.4	1.6	1.6	1.7	1.8	1.7	1.5	1.9	2.2	2.1	2.7	2.8
82- 93	2.3	1.7	1.8	2.1	2.2	1.6	1.9	1.9	1.5	1.2	2.2	1.4	1.8	1.4	1.9	1.8	1.4	1.8	1.3	1.3	1.2	1.4	1.9	1.4	2.1	2.3
94-207	2.5	2.1	1.8	1.8	2.2	2.0	2.1	1.9	1.6	1.7	1.8	1.7	2.0	1.7	1.9	1.7	1.6	1.5	1.8	1.7	1.6	1.7	2.0	1.7	2.4	2.4
208-252	2.8	2.1	2.6	2.5	2.5	2.4	2.5	2.3	2.0	2.2	2.6	2.6	2.5	2.1	2.4	2.4	2.1	2.3	2.3	2.0	2.1	2.3	2.5	2.6	2.7	2.6
253-271	2.9	2.2	2.7	2.8	2.8	2.5	2.4	2.4	2.1	1.9	2.2	2.4	2.3	1.9	2.4	2.7	2.3	2.2	2.1	1.7	1.9	2.0	2.4	2.5	2.8	2.8
272-292	2.6	1.9	1.9	2.4	2.5	2.1	1.3	2.0	1.8	1.6	1.8	1.7	1.9	1.5	2.0	1.7	1.3	2.0	1.9	1.5	1.4	1.6	1.9	1.8	2.6	2.6
293-325	2.5	2.4	2.5	2.2	2.4	2.1	2.2	2.2	2.0	1.9	2.3	2.3	2.0	2.1	2.1	2.3	1.9	1.9	2.1	2.2	2.0	1.8	2.6	2.3	2.8	2.6
326-341	2.9	1.6	2.0	2.0	2.5	2.4	2.5	2.6	1.6	1.6	2.6	1.9	1.6	1.6	2.6	2.1	1.3	2.1	1.8	1.3	1.7	1.7	2.5	1.7	2.9	2.8
342-364	2.9	2.7	2.7	2.8	2.9	2.7	3.0	2.8	2.8	2.5	2.8	2.7	2.5	2.6	2.1	2.5	2.1	2.2	2.6	2.5	2.5	2.8	2.9	2.8	3.0	2.9
365-405	2.5	2.2	2.3	2.3	2.2	2.2	2.0	2.0	1.8	1.9	2.2	2.2	2.2	1.8	2.2	2.0	1.8	1.8	1.9	1.7	1.7	1.7	2.1	2.0	2.3	2.4
406-480	2.9	2.3	2.0	2.1	2.2	2.1	2.4	2.1	1.7	1.6	2.0	1.5	2.0	1.6	2.1	1.5	1.3	1.6	1.7	1.5	1.3	1.6	2.2	1.7	2.6	2.8
481-491	1.5	1.1	1.4	1.3	1.5	1.2	1.3	1.3	1.2	1.2	1.2	1.4	1.5	1.1	1.4	1.5	1.1	1.5	1.3	1.1	1.1	1.4	1.7	1.4	1.7	1.5
492-591	2.0	1.7	2.0	1.8	1.8	1.8	1.8	1.6	1.7	1.9	2.0	1.8	2.0	1.7	1.9	1.8	1.6	1.8	2.0	1.8	1.6	1.5	2.0	1.7	2.1	2.2
TOTALS																										
Mean Weighted Rtg/Skill	2.5	2.0	2.1	2.1	2.2	2.0	2.1	2.0	1.7	1.6	2.0	1.8	2.0	1.7	2.0	1.9	1.6	1.8	1.8	1.6	1.6	1.7	2.1	1.9	2.4	2.4

Appendix N

Computation: (r of knowledge of concepts)

$$r = \frac{N\,EXY - (EX)(EY)}{\sqrt{[N\,EX^2 - (EX)^2][N\,EY^2 - (EY)^2]}}$$

$$r = \frac{75\,(200.7) - (108.0)(137.1)}{\sqrt{[\,75(159.9) - (108.0)^2\,][75(255.8) - (137.1)^2\,]}}$$

$$= \frac{15052.5 - 14806.8}{\sqrt{(11992.5 - 11664)\,(19185 - 18796.4)}}$$

$$= \frac{245.7}{\sqrt{(328.5)(388.6)}}$$

$$= \frac{245.7}{357.3}$$

$$r = 0.688$$

Computation : (r of laboratory skills)

$$= \frac{51\,(181.0) - (83.1)(108.3)}{\sqrt{[\,51(140.9) - (83.1)^2\,][\,51(235.1) - (108.3)^2}}$$

$$= \frac{9231 - 8999.7}{\sqrt{(7185.9 - 6905.6)(11990.1 - 11728.9)}}$$

$$= \frac{231.3}{\sqrt{(280.3)(261.2)}}$$

$$r = 0.854$$

CURRICULUM VITAE

NAME	:	COSETTE CASIMERO - OLIVA
ACADEMIC RANK	:	Associate Professor II
HOME ADDRESS	:	Catbalogan, Samar
CIVIL STATUS	:	Married
BIRTHDAY	:	October 24
HUSBAND	:	Bernardo Oliva, Sr., Ph.D.
CHILDREN	:	Lyn, Bernardo Jr., Rey, Paul, Eric, Gay

EDUCATIONAL QUALIFICATION	YEAR COMPLETED
Bachelor of Science in Chemistry	1960
Master of Arts in Teaching Chemistry	1983

CIVIL SERVICE EXAMINATIONS	YEAR PASSED
Board Examination for Chemists	1960
Profesional Career Service Examination	1968
DECS - CSC Teachers' Examination	1972

RECORD OF SERVICE	INCLUSIVE DATES
Classroom teacher	11/ 6/61 - 6/16/75
Junior College Instructor	6/17/75 - 6/12/78
Instructor I	6/13/78 - 6/21/81
Instructor II	6/22/81 -12/31/83
Assistant Professor I	1/ 1/84 - 6/30/84
Assistant Professor II	7/ 1/84 -12/31/86
Assistant Professor V	1/ 1/87 -12/31/88
Assistant Professor VI	1/ 1/89 - 6/30/89
Associate Professor II	7/ 1/89 -

SUPERVISORY EXPERIENCE

Subject Area Chairman, Science	9/ 4/84 - 7/ 4/88
Head,Arts and Sciences	7/ 5/88 - 7/ 3/89
Head, Research	7/ 4/89 -

SCHOLARSHIPS ENJOYED	SPONSOR/CENTER	DURATION
International		
Research-Based Diploma Course on Science Teaching in Vocational Education	SEAMEO-RECSAM Penang, Malaysia	Jan.2,1989-June 30, 1989
National		
Chemistry Teacher Training Course	SHELL-BVE UP, Diliman	SY 1967-68
MECS-MIST Integrated Scholarship	MECS - MIST Marikina,MM	SY 1981-82
Teacher Training Upgrading Course	MIST,Marikina, Metro Manila	Summer,1986
Local		
SSPC-Faculty Development Program	SSPC, Catb.,Samar	SY 1986-

MEMBER : The Integrated Chemists of the Philippines Organization

Philippine Association of Chemistry Teachers (National level)

Philippine Association for Vocational Education

AWARDS RECEIVED	GIVEN BY
Certificate of Merit for Scholastic Excellence	U.P.,Diliman
Certificate of Appreciation in Recognition for Valuable Participation in the 1968 National Workshop on Chemistry Teaching	UNESCO,Phil.
Katibayan ng Pagpahalaga Bilang Tagapayo ng Nagwagi ng Unang Gantimpala sa Pampurok na Tanghal-Agham, 1974	Science Foundation of the Phil.
Sagisag ng Pagtatangi Bilang Kasangguni sa Seminar-Workshop for Science Club Advisers	SFP
Award Certificate for Having Distinctively Passed Two Examinations Given by Siribbot Soreach, Author, High School and Modern Math Textbook Series; One of the 15 Award Certificates granted out of 65 participants of an 18 day seminar for High School Teachers.	Father Urios College
Certificate of Commendation as Subject Area Specialist in the Seminar-Workshop on Upgrading Competencies for Effective College Teaching	Samar State Polytechnic College
Certificate of Recognition for Dedicated Service in the Training and Development of the Youth and Loyalty to the Institution for 21 Years	SSPC
Certificate of Recognition for the Successful Participation in the External Monitoring and Evaluation of the LAKASS Program	National Nutrition Council

SERVICES RENDERED IN SEMINAR-WORKSHOPS:

Discussant	:	Regional-Seminar workshop on Curriculum Design and Development Including Achievment Testing (Phase IV) -Samar SAT, April 7-26, 1980
Syndicate Adviser	:	Regional Seminar-Workshop on Curriculum Design and Development Including Achievement Testing (Phase IV) - Samar SAT, May 5- 24 , 1980

Adviser/ Facilitator	:	Seminar-Workshop on Curriculum Design and Development Including Achievement Testing (Phase II-A) - Samar SAT, December 4, 1979
Resource person	:	Division Science Seminar on Science and Math in the Revised Secondary Curriculum - DEC, Division of Samar, September 13, 1974

CONFERENCES, SEMINARS, WORKSHOPS ATTENDED	SPONSORING AGENCY	DATE
In-Service Seminar on"Chemistry and Society"	PACT-FAPE-PSMC	5/24-26 /88
Seminar-Workshop on Alternative Strategies for Effective Teaching: Information Processing	U.P. Visayas	10/5-10 /87
Seminar-Workshop on Work Values Development	NMYC-SSPC	6/25-27 /86
Seminar-Workshop on Use of Audio-Visual Aids in Chemistry Teaching	PACT-FAPE-PSMC	5/1-4 /86
Seminar-Workshop on Upgrading Competencies for Effective College Teaching, Focus: Syllabus Making and Test Construction	SSPC	11/4-8 /85
Second Regional Staff Development for College Teachers: Focus on Upgrading Competency for Instructional Evaluation	MECS-RO VIII	10/16-17/85
Follow-thru Seminar-Workshop on the Upgrading of the Two-Year Technical and Four-Year Teacher Education Curricula	Samar SAT	3/26-27 /81
Course in Curriculum Design and Development Including Achievement Testing (Phase II)	Samar SAT	8/1-9/28 /87
Astronomy-Chemistry Regional Seminar-Workshop	DWU, Tac.	9/13-16 /77
Seminar-Workshop on the Re-Appraisal of the Technician Education Program	EDPITAF/ Interim Board of Tech Educ/ LIT	12/2-4 /86

Seminar-Workshop on the Implementation of the Revised Secondary Education Program	DEC-RO VIII	5/5-9/75
Biotechnological Extension Course	NIST-NSDB	9/26-10/24/72
Evaluation as an Integral Part of the Teaching-Learning Process	FAPE/Fr.Urios College	9/20-21/71
Modern Math Seminar	Fr.Urios Col.	Mar.- Apr.,1971

PUBLISHED ARTICLES WRITTEN

Literature Review on Understanding -	SSPC Graduate Studies and Research Journal, 1989, vol.VI,(1)
The Asbestos Hazard in Automotive Service Facilities	- do -

UNPUBLISHED WORK:

"Chemical Concepts Relevant to Automotive Technology" - Seminar Paper, M.A.T.(Chem).MIST,1982

"Understanding of Electrochemical Concepts Related to the Lead Storage Storage Battery by Automotive Technology Students in Samar State Polytechnic College, Philippines .....a Research Paper for the Diploma Course in SEAMEO-RECSAM, Penang, Malaysia, June, 1989.

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