

**DEVELOPMENT AND VALIDATION OF MODULES ON MATTER
IN MATERIALS CHEMISTRY 101**

A Thesis

Presented to

The Faculty of the College of Graduate Studies

Samar State University

Catbalogan, Samar

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts in Teaching
Major in Chemistry

VIVIAN L. MOYA

September, 2008

APPROVAL SHEET

This thesis entitled "DEVELOPMENT AND VALIDATION OF MODULES ON MATTER IN MATERIALS CHEMISTRY 101," has been prepared and submitted by VIVIAN L. MOYA, who having passed the comprehensive examination, is hereby recommended for oral examination.

esteban malindog
ESTEBAN A. MALINDOG, JR., Ph.D.
Professor, SSU
Adviser

Approved by the Committee on Oral Examination on September 12, 2008
with a rating of PASSED.

Marilyn Cardoso
MARILYN D. CARDOSO, Ph. D.
Dean, College of Graduate Studies, SSU
Chairman

Jose S. Labro
JOSE S. LABRO, Ph. D.
Vice President for Administrative Affairs, SSU
Member

Adela S. Abaincia
ADELA S. ABAINCIA
Professor, SSU
Member

Elmer A. Irene
ELMER A. IRENE
Professor, SSU
Member

Accepted and approved in partial fulfillment of the requirements for the
Degree, Master of Arts in Teaching major in Chemistry.

September 12, 2008
Date of Oral Defense

Marilyn D. Cardoso
MARILYN D. CARDOSO, Ph.D.
Dean, College of Graduate Studies

ACKNOWLEDGMENT

The researcher wish to express her gratitude and sincere appreciation to the following people for their role in making this study possible:

Dr. Esteban A. Malindog, Jr, my thesis adviser, for being there from start to finish, providing me with valuable guidance and advice. I am especially grateful to him for giving me the freedom and space to explore and discover things for myself, while keeping his ever-watchful eye from a distance;

Dr. Marilyn D. Cardoso, Dean of College of Graduate Studies for her competent guidance and untiring support for the completion of this study. Her gentle reassurances and encouragement at various times in the course of my study are very much appreciated;

Dr. Simon P. Babalcon Jr., University President for allowing me to work and study at the same time. A large part of my ability to complete this study within this time was due to his approval to work in the main campus for the experimentation of the study;

Dr. Jose S. Labro, Vice President for Administration and panel member, Prof. Elmer Irene, for their invaluable suggestions and criticisms for the improvement of the manuscript;

Prof. Adela A. Abaincia for her support, encouragement and allowing us use the laboratory materials needed during the experimentation;

Mrs. Florencia L. Lagria for the moral support and encouragement;

I am grateful to Prof. Edelyn Echapare for allowing me to use her class for the experimentation. I especially appreciate her friendship and support;

To all BS InfoTech freshmen enrolled during the SY 2008-2009, respondents of this study, I am truly grateful for their participation;

Mrs. Rebecca Sabbare and Mrs. Alice Pag-liawan for the ready smile and assistance during my library research.

To my Pastor, Rev. Samuel R. Nacionales and my family in Gospel Baptist Church to mention Ate Nit, Ate Joy, Ate Ching, Janice, Marnie and others for their moral support, the words of encouragement and the tremendous amount of goodwill. My spirits were sustained by their sympathy in the most frustrating moments of this pilgrimage, and by their sharing of my joy whenever I completed a chapter.

Life would have been just too tedious without the daily contact with my friends and colleagues Toneth, Mana Ner, Onjie, Marvin, Maricel, Mana Ema, Mano Sale.

To my parents, MSgt Vivencio C. Lucaban and Ligaya B. Lucaban and sisters Liberty, Venice and Venus who offered me unconditional love and support throughout the course of this thesis.

To my husband Jay-ar and son Vintoy for always believing in me.

Above all, all thanksgiving and honor is given to our God Almighty who makes all things possible.

Dedication

I dedicate this humble work to the Lord. I am eager to see how He uses this work in my life and the lives of others. All glory to him and honor.

To my husband and son Vintoy who had been a great source of motivation and inspiration. You have been with me every step of the way, through good times and bad. Thank you for all the unconditional love, guidance, security and support that you have always given me, helping me to succeed and instilling in me the confidence that I am capable of doing anything I put my mind to. Thank you for everything. I love you!

Finally, this thesis is dedicated to all those who believe in the richness of learning.

Vivian

ABSTRACT

This study developed modules on Matter in Materials Chemistry 101 and validated their effectiveness in relation to students' skills and performance. The study determined how effective the developed modules were based on an active learning approach. This study employed two research designs. The descriptive-developmental design was used during the development stage using the Interest Inventory as its instrument. There was no significant difference between the post-test mean scores of the two groups of respondents for the reason that when t-test for independent samples was employed, it yielded a computed t of 1.42 which is higher than the tabulated t of 2.00. This led to the acceptance of the hypothesis. Based on the 30 sample pages taken from the active learning materials, the Reading Ease Score (RES) turned out to be 50.62 which meant that the readability of the developed active materials for active learning approach in Chemistry were appropriate for the first year to second year college students. Moreover, the Human Interest Score (HIS) was posted at 36.13 which classified the materials at an "interesting level". The two methods of teaching, the Traditional Lecture-Discussion Method of Teaching and the Active Learning Approach are equally effective on the basis of the post-test scores of the two groups. This shows that the use of any of the two methods would have the same result on learning among Freshmen College students. Teachers should make use of active learning strategies in teaching college Chemistry besides the traditional lecture discussion method to break the monotonous mode in the classroom.

TABLE OF CONTENTS

	Page
TITLE PAGE	i
APPROVAL SHEET	ii
ACKNOWLEDGMENT	iii
DEDICATION	v
ABSTRACT	vi
TABLE OF CONTENTS	xiv

Chapter

1 THE PROBLEM AND ITS SETTING	1
Introduction	1
Statement of the Problem	4
Hypotheses	5
Theoretical Framework	6
Conceptual Framework	8
Significance of the Study	10
Scope and Delimitation	12
Definition of Terms	13

Chapter	Page
2 REVIEW OF RELATED LITERATURE AND STUDIES	17
Related Literature	17
Related Studies	27
3 METHODOLOGY	41
Research Design	41
Instrumentation	42
Validation of the Instrument	44
Sampling Procedure	50
Data Gathering Procedure	50
Statistical Treatment of Data	53
4 PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA	59
Profile of the Subjects	59
Level of Interest of the Students in Chemistry 101	65
Readability Level of the Module	68
Pretest Results of the Experimental and Control Groups	69
Pretest and Posttest Scores of the Control Group	71
Pretest and Posttest Scores of the Experimental Group	73
Posttest Results of the Experimental and Control Groups	75

Chapter	Page
Evaluation of Module by the Experimental Group	75
5 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS	79
Summary of Findings	79
Conclusions	81
Recommendations	82
6 THE MODULE FOR ACTIVE LEARNING IN TEACHING CHEMISTRY 101	84
BIBLIOGRAPHY	207
APPENDICES	215
CURRICULUM VITAE	240
LIST OF TABLES	
LIST OF FIGURE	

Chapter 1

THE PROBLEM AND ITS SETTING

Introduction

The mark of a chemistry teacher who has grown in teaching is his/her ability to organize and develop instructional materials suited to the students' level of readiness, capabilities and understanding. The teaching-learning process has been the concern of chemistry educators. The problem of how to make teaching more effective and for optimum learning to take place has beset the educational system as a whole.

Ibe (1998) as cited by Cuyegkeng (2001) pointed out that

...the general observation that students attend chemistry class simply to fulfill a requirement is probably not confined to the Philippines. Fewer students appreciate the thinking and rigor that goes with the subject. In the Philippine educational system, one of the most disturbing problems is the poor achievement of Filipino students in the areas of science and technology.

Firstly, in a latest study entitled "Trends in International Mathematics and Science Study reported in 2003, Filipino students performed dismally in Math and Science international tests ranking 41st and 42nd respectively, among 45 participating countries. Secondly, in a diagnostic test given by the Department of Education, only 30.00 percent of Grade VI students have mastered their expected competencies in English, math and science subjects. The results further revealed that generally, students could correctly answer only half of the

questions in NEAT and NSAT. The lowest scores were recorded in Science and Math indicating that these are the most difficult subjects for the students (PCER, 2000). Hence, educators agreed that one of the major causes of this problem has to do with the method of facilitating the learning of mathematics and science concepts and processes inside the classroom. Somehow, the current methods do not fully develop skills of both students and teachers.

The findings of UP Professor Dr. Milagros D. Ibe and DOST SEI Director Dr. Ester B. Ogena revealed that there has not been improvement since 1981, when Mathematics Teacher's Association of the Philippines (MTAP), the Mathematics Society of the Philippines (MSP) and the Ateneo FAFE Graduate Center for Math and the National Science and Technology Authority (now DOST) made a situational study of the status of Science and Mathematics teaching in the country.

The three professional agencies in coordination with the government agency administered an examination with test items taken from Mathematics textbooks the teachers are using and involved straightforward applications of essential topics in their respective classroom. Among secondary schools, only 13 or 8.00 percent of the teachers scored five or higher in the 10-item test and there were many zeros.

Similarly, many science teachers observed that majority of the students do not appreciate science particularly chemistry. Having been teaching for eight years, the researcher noticed that it is very difficult to get the attention of the

students during lecture especially when the topic is about things which cannot be directly observed and seen by the naked eyes. Magno and Ferido (1999: 15) pointed out that the negative attitude of the students towards science especially in the field of chemistry is due to the traditional way of teaching. Thus, there is a need to begin reforms in teaching; employing those particular approaches fostering active learning that match students' needs and particular courses, and teachers' teaching styles and personalities. It is proposed that strategies promoting active learning in modules be defined as instructional activities involving students in doing things and thinking about what they are doing.

The Philippine Education Quarterly (1985, as cited in Figuerres, 1994) reported that modules can take the place of a teacher. These self-learning devices help pupils to learn or acquire skills, knowledge and information in the absence of a teacher. These materials provide sufficient reinforcement, enrichment and source materials. They also allow the learner to work at a rate, style and level situated to his capacity.

Among the forms of individualized instruction, modules are effective and economical in developing specific knowledge and skills, especially in chemistry. Modules induce learning with minimum teacher direction and supervision.

In the Philippine educational system, learning modules are attributed to well-known educators such as Torralba. Chancellor Librero of the University of the Philippines (Open University, 2002) contends that education in their system is highly dependent on modules and instructional materials used by students,

notwithstanding the quality of teachers and other school facilities. He emphasized further that 30.00 percent of the student tuition fees goes to the production of instructional materials.

Samar State University is an institution aimed at attaining academic excellence to promote quality education. It is timely that the university would seek measures to improve quality and relevant education by providing students with instructional materials that cater to their needs and interest and allow students to progress at an optimal rate. Furthermore, this study would contribute to the solution of lack of instructional materials for college chemistry students. Also, it is hoped that this study would encourage achievement for greater use of existing educational resources. It is in this context that the researcher was motivated to conduct this research study.

Statement of the Problem

This study developed modules on Matter in Materials Chemistry 101 and validate their effectiveness in relation to students' skills and performance. The study determined how effective the developed modules based on active learning approach. Specifically, it sought answers to the following questions:

1. What is the profile of the first year BS Information Technology students in terms of:
 - 1.1 age;
 - 1.2 sex;

- 1.3 scholastic performance in high school, and
- 1.4 average family income per month?
2. What is the level of interest of the students in Chemistry 101?
3. Based on the interest inventory, what topics in Chemistry 101 can be developed as modules for active learning approach in Chemistry 101?
4. How effective are the developed materials based on the following:
 - 4.1 Is there a significant difference between the pretest mean scores of the control group and the experimental group?
 - 4.2 Is there a significant difference between the pretest and posttest mean scores of the control group?
 - 4.3 Is there a significant difference between the pretest and posttest mean scores of the experimental group?
 - 4.4 Is there a significant difference between the posttest mean scores of the control and the experimental group?
5. What is the readability level of the materials in terms of:
 - 5.1 Reading Ease Score (RES), and
 - 5.2 Human Interest Score (HIS)?

Hypotheses

Based on the aforementioned specific questions, the following hypotheses were formulated and tested:

1. There is no significant difference in the pretest mean scores of the control and the experimental group.
2. There is no significant difference between the pretest and posttest mean scores of the control group.
3. There is no significant difference between the pretest and posttest mean scores of the experimental group.
4. There is no significant difference between the posttest mean scores of the control and the experimental group.

Theoretical Framework

Learning by doing is a theme that many educators have stressed that children must be engaged in an active quest for learning new ideas. This study was anchored on John Dewey's theory of experience. Dewey (1902) explained that education must be designed on the basis of a theory of experience and that learning is active. It involves reaching out of the mind. It also involves organic assimilation starting from within. It is the student and not the subject-matter which determines both the quality and quality of learning. Thus, Dewey proposed that education be designed on the basis of a theory of experience. There is a need to understand the nature of how humans have the experiences they do, in order to design effective education. With this ultimate philosophy, teachers have to give way and shift their role as facilitators of student-learning activities rather than as ultimate regurgitators. Hence, in active learning approach,

students themselves are the main focus of the attention where they are engaged in activities such as reading, discussing and writing. Also, teachers must emphasize the critical role that experiences play in student learning.

Jean Piaget also stressed the need for concrete operations in early childhood (Labinowicz, 1980). A central component of Piaget's developmental theory of learning and thinking is that both involve the participation of the learner. Knowledge is not merely transmitted verbally but must be constructed and reconstructed by the learner. Piaget asserted that for a child to know and construct knowledge of the world the child must act on objects and it is this action which provides knowledge of those objects (Sigel, 1977). The learner must be active, he is not a vessel to be filled with facts. In active learning, the teacher must have confidence in the student's ability to learn on his own. This is what active learning is all about.

This study is also anchored on Froebel's theory that "all learning comes through self-activity" (Froebel, 1950). He claimed that education is a natural process; that the child is an organic whole which develops through creative self-activity according to natural laws. He stressed the importance of pleasant surroundings, self-activity and physical training in the development of the child. Gregorio (1976) cited that self-activity is a requirement of all learning and of all mental, physical, emotional and social growth and development.

In active learning, the principle of self-activity is emphasized wherein it does not demand of activity alone but all-sided activity of the whole self. Hence,

this approach in teaching requires the learners to participate in planning, executing and evaluating tasks. If learning is to be effective, there should be an active participation of the students in the learning process.

Conceptual Framework

The paradigm (Figure 1) below depicts the conceptual framework of the study. It served as guide of the researcher in conducting the study.

The schema explains that the research environment was the Samar State University Main Campus, Catbalogan City, Samar and the respondents of the study were the selected first year students under the curriculum Bachelor of Science in Information Technology. The lower box shows the development stage which is the construction and validation of the interest inventory instrument was made before the start of the experiment. The Interest Inventory was done to find out what topics in Chemistry 101 can be developed as materials for active learning approach. Results showed that the topic "Matter" interests students most and can be developed as active learning materials. The upper box shows the process used in the conduct of the study. The study used the randomized pretest and posttest design. The respondents were divided into two groups namely: the control group and the experimental group. Each group consisted of 30 students each. The study considered the modules on active learning approach as the independent variable or treatment variable while the

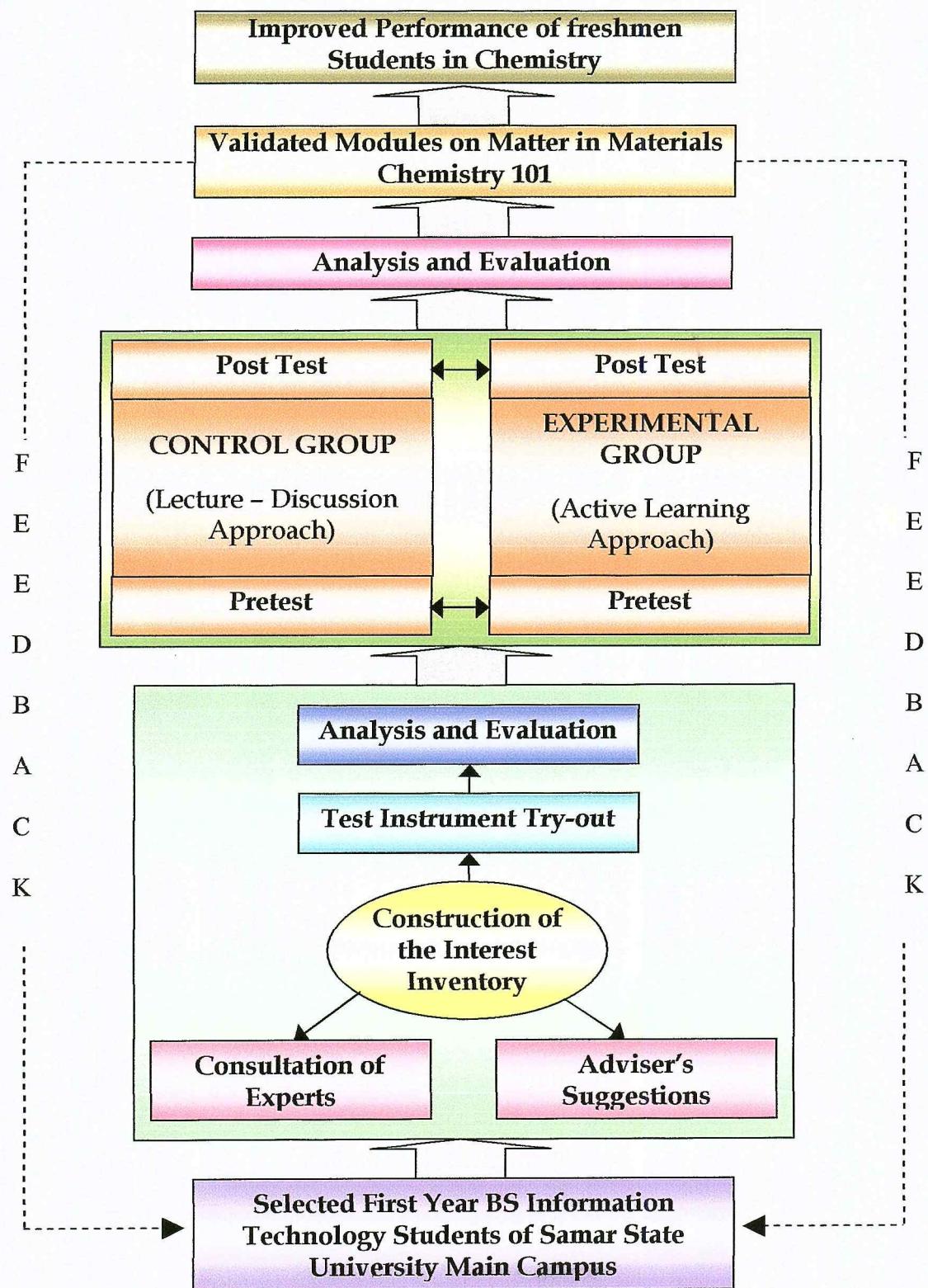


Figure 1. Conceptual Framework of the Study

pretest and posttest results were considered as the dependent or criterion variables. The experimental group was taught using the active learning approach while the control group was taught using the traditional lecture-discussion method. The researcher herself handled the two groups of subjects.

A pretest was given to both control group and experimental group before the start of the experiment. The pretest results of both groups were compared to ascertain that the entry behaviors of both groups are the same before the start of the experiment. A posttest was then given to both groups after the experimentation to determine the knowledge gained in chemistry. The performance of students in both pretest and posttest were compared and evaluated to determine the difference in performance of both groups. The results served as the basis of the study which was the validated module on matter for active learning approach in Chemistry 101. The top frame shows the outcome of the study which was the improved performance among freshmen college students in chemistry.

Significance of the Study

The developed modules based on the active learning approach would benefit students, teachers, parents, administrators and future researchers in their quest for quality education.

To the students. The use of the modules using the new approach would aid students to become active and independent learners. As the famous adage

says, knowledge is best "wrung out" of students rather than "poured out." In other words, things are better learned by doing than by listening. It would develop their potentials through self-discovery and self-realization at their own rate. Thus, this would lead to an improved performance in the subject. Student's involvement in the educational process would help students recognize and accept their responsibility for lifelong learning and continued professional development. The value of cooperation would also be developed for they will also be encouraged to work together in some experiments that they will be doing.

To the chemistry teacher. Using the active learning modules would help the faculty to become knowledgeable about the many ways strategies promoting active learning. It would also mean lesser talk on the part of the teacher thus providing enough time to pay attention to the performance of the individual and thus cater to the individual needs of the students. It would also help teachers in planning active learning situations that would set learners free to think and investigate concepts and principles in their immediate environment.

To the parents. The material would give them the assurance that mastery learning is given emphasis. They would be able to place their trust and confidence to the school and the teacher capability to educate their children.

To the administrators. The findings of this study would serve as an input so the administration can decide well on what policies and strategies may be formulated to improve students' performance in the classroom.

To the future researchers. This study would stimulate them to make a step further from this by conducting an experimental research in other topics in chemistry or other fields of discipline to determine if the achievement of children will be significantly better in an activity-oriented program than in the traditional program. It would provide a ready review of related research literature as well as provide inputs to their own researches.

Scope and Delimitation

This study was confined to the development and validation of modules on Matter in Materials Chemistry 101 intended for the first year students of Samar State University under the four-year curriculum leading to the degree of Bachelor of Science in Information Technology.

A total of 60 first year Bachelor of Science in Information Technology students were selected by purposive sampling technique. Thirty students comprised the control group and the other thirty students composed the experimental group. It used the pretest which was given to both control and experimental group before the experimentation and posttest after the experimentation.

The lesson covered was limited to one chapter which is 'matter.' The experiment was conducted during the first semester of the year. (First Semester School Year 2007-2008) of which the researcher handled the two groups of respondents.

Definition of Terms

To provide a common frame of reference to readers, the following terms are herein defined conceptually and operationally.

Active learning approach. This term refers a learning approach that allow students to talk and listen, read, write, and reflect as they approach course content through problem-solving exercises, informal small groups, simulations, case studies, role playing, and other activities -- all of which require students to apply what they are learning (Meyers and Jones, 1993). As used in this study, it refers to a teaching approach where modules are used in the instruction.

Chemistry. This term refers to a branch of science which deals with the study of properties, composition and structure of matter, the changes or transformations it undergoes and the laws and principles which govern such changes (Gove, 1986).

Control group. This term refers to a group subjects closely resembling the treatment group in many demographic variables but not receiving an active medication or factor under study and thereby serving as a comparison group when treatment results are evaluated (Random House Unabridged Dictionary, 1993: 442). As used in this study, this term refers to a group composed of 30 BS Information Technology students with whom lecture discussion method of instruction in Chemistry was used.

Effectiveness. This term refers to a quality or state of being effective; efficacy (Webster's Third New International Dictionary, 1986: 725). In this study, this term refers to the significant gains in the posttest results as compared with the pretest results.

Experimental group. Conceptually, this term refers to a group that was exposed to the treatment under consideration (Herrin, 1987). Operationally, this term refers to thirty students with whom active learning approach was used in the instruction of Chemistry concepts.

Flesch formula. Method of determining the degree of ease or difficulty in reading a text or document by counting the syllables and sentences per 100 words. Named after Dr. Rudolf Flesch (1911-86), US linguist and readability expert, also called Flesch test. (<http://www.businessdictionary.com/definition/Flesch-formula.html>)

Human interest score (HIS). One of the Flesch indices of the readability of text, defined by the formula $HIS = (3.635 \times \text{average number of personal words per 100 words}) + (0.314 \times \text{average number of personal sentences per 100 sentences})$, where personal words are pronouns referring to people, words of identifiable masculine or feminine gender, and the words people and folks, and personal sentences are spoken sentences in quotation marks, questions, commands, requests, other sentences addressed directly to the reader, and also exclamations and grammatically incomplete sentences whose meaning has to be inferred from their contexts (Dictionary of Psychology, 2001).

Interest inventory. A self assessment tool, used in career planning, that assesses one's likes and dislikes of a variety of activities, objects, and types of persons; the premise is that people in the same career have similar interests (McKay, 2002: online). In this study, it refers to an attitude scale designed to find out which topics in Chemistry can be developed as materials for active learning.

Module. This term refers to a self-learning kit which consists of a package of lessons and primarily focuses on well-defined objectives (Lardizabal, 1991). In this study, the term refers to prepared instructional materials.

Posttest. Generally, the posttest refers to a test given after the introduction of the experimental factor or project (Herrin, 1987). In this study, this refers to a 30-multiple choice open ended test that was administered to both experimental and control group after the experimental intervention. This was done to determine the knowledge gained in Chemistry by two groups of respondents. The content of this test is the same as those of the pretest but the arrangements of these items were modified to avoid bias in the results.

Pretest. This term refers to a preliminary test which serves to explore rather than evaluate (Webster, 1986). In this study, this refers to a 30-item test in Chemistry 101 that was administered to both the experimental and control group before the experimental activity to determine the extent of knowledge they have the topic covered.

Reading ease score (RES). One of the Flesch indices of the readability of text, defined by the formula $RES = 206.835 - (1.015 \times \text{average number of words})$

per sentence)–(84.6 × average number of syllables per word). Reading ease scores have been found to correlate highly with ratings of readability and with measures of comprehension and retention (Dictionary of Psychology, 2001).

Traditional approach. Conceptually, this term means the use of an inherited or established way of doing (Webster, 1986). As used in this study, this refers to the combined lecture-discussion method which was used by the teacher in teaching the content of Chemistry.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents and discusses ideas about development of instructional materials and active learning approach taken from published materials such as books, journals and periodicals which are relevant to the present study. This also includes excerpts from unpublished materials such as master's theses and doctoral dissertation that are related to the present study.

Related Literature

The succeeding related literature were reviewed and made part of this study to supplement its contents and give it more substance in order to make this study worthy and meaningful.

In her speech on Physics education for Philippines 2000, Talisayon (1994) opined that people empowerment in science education is improving students and teachers with the knowledge, skills and values needed for a newly industrialized country and for international competitiveness. This demands excellence on both students and teachers.

Transmission of knowledge, skills and competitiveness always involves instructional methodologies that are ideally at the disposal of the teacher. The choice of each approach, methodology and strategy is highly dependent on the teacher's definition of learning, teaching, knowledge and the nature of the

learner. It is therefore the teacher's role to increase knowledge on the current innovations in the use of instructional materials and teaching strategies.

This literature is related with the present study inasmuch that both deals with improving learners as well as teachers in using new teaching innovations. Careful planning and selection of material is very important to insure its effectiveness. Moreover, it should influence the learner to develop critical thinking and contribute to the development of good human relation through the inculcation of sound and moral ethical values.

Johnson (2006: online) conducted research on developing a mentorship program on non-traditional teaching and learning strategies. According to them, in the late 1980's national attention has begun to focus on the quality and outcomes of university classroom teaching. Paralleling this emphasis has been a growing body of pedagogy centered on non-traditional teaching and learning techniques. These techniques include active learning approach in teaching, collaborative learning, cooperative learning, problem-based learning and small group teaching. Collectively these teaching techniques emphasize self-directed student learning, teachers as facilitators or guides, cooperative learning in student small groups and acquisition of critical thinking, writing and speaking skills. The body of research and evaluation investigating these teaching methods has revealed higher achievement and productivity relative to traditional teaching models of lecture-based individualistic learning.

This literature is related with the present study inasmuch as both deals with non-traditional teaching which include active learning as one of the current teaching innovations.

Ornstein (1990: 217) suggested some basic guidelines for using instructional aids and guides for selecting and using instructional materials. According to him, there must be purpose for using instructional materials. Clearly defined objectives are essential for planning the lesson, selecting and using instructional materials. The material should also be flexible. It should be able to satisfy many different purposes. It should cater to the needs of the students such as age, ability and interest of the students. Most importantly, it should guide learners and evaluate results that will check student's reaction to the instructional material.

The literature of Ornstein gave the researcher important insights as to the content of the active learning material that was used in the experimentation. Objectives are very essential in developing the materials for active learning approach.

Religioso (1995: 67) added that the main feature of an individualized instruction is that students are presented with learning materials that have been designed to meet their own needs, interests and abilities. It becomes very effective teaching method when it is used in conjunction with other methods of teaching that enhance sharing and cooperation among students like team learning, peer tutoring and discussion. One of the advantages of individualized

instruction is its flexibility. It allows more student choices and more independent work. It helps in the development of self-discipline individual and a sense of personal achievement. The teacher plays a less dominant role. After developing the materials, he/she devotes more time giving encouragement and feedback to the individual students.

In an article entitled "Where's the evidence that active learning works?" by Joel Michael (2006), the author quoted the words of one of the most pointed critiques in science education articulated by Volpe (1984) and his words are as relevant today as they were more than 20 years ago. He quoted to wit

Public understanding of science is appalling. The major contributor to society's stunning ignorance of science has been our educational system. The inability of students to appreciate the scope, meaning, and limitations of science reflects our conventional lecture-oriented curriculum with its emphasis on passive learning. The student's traditional role is that of a passive note-taker and regurgitator of factual information. What is urgently needed is an educational program in which students become interested in actively knowing, rather than passively believing.

Michael (2006) added that calls for reforms in the ways we teach science at all levels, and in all disciplines, are wide spread. The effectiveness of the changes being called for, employment of student-centered, active learning pedagogy, is now well supported by evidence. Pedersen and Liu (2003) pointed out that "student centered" is usually defined in opposition to "teacher centered," and Barr and Tagg (1995) have discussed a change in the educational paradigm from one that focuses on teaching to one that focuses on learning. For example, a

conventional lecture-based course is said to be teacher centered because of the view that what matters most in determining what is learned is what the teacher does in the lecture hall.

Kalem & Fer (2003) searched the effects of a model designed for active-learning on the students' view of learning, teaching, communication and learning environment. According to the study realized on the university students, it was seen that the teaching carried out through active learning had positive effects in view of learning, teaching and communication.

Peterson (1979) as cited by Lemlech (1979) compares the effects of individualized learning versus the traditional approaches on student achievement. She concluded that a student who experiences self-learning does better achievement test. The student whose style is self-directed approaches facilitates creative thinking and problem solving. They also improve student's attitudes toward school and teachers and increase students independence and curiosity.

As seen from the results of the studies presented above, it is determined that attitude and success of the students are effectively increased by using active learning techniques. Through this point of view, it can be clearly claimed that active learning is an effective way of teaching. Both literature presented by Kalem and Peterson were related with the present study since they tackled on the effectiveness of active learning on student learning.

The following methods of self-pacing methods, modular teaching, programmed instruction, self-learning kit and distance education may have different names but they are practically the same in many aspects (Calderon 1998). According to him, these methods have the same purpose, that is, to make each student progress at his own rate because instruction is individualized. They enable each student to study learning materials as thoroughly as he can so that expected learning skills are acquired. These methods are also similar in terms on how the lessons are presented. The whole course is divided into logically sequenced topics, each topic being a learning unit itself. Because instruction is individualized, the tests are criterion-referenced. This is knowing how much the student learned based on the criteria set.

Active learning approach of instruction can also be considered as one of self-pacing methods. Like the methods presented by Calderon, active learning approach enables student to study learning materials in which topics are also arranged logically. Also, interaction between students and teachers is minimal.

The literature of Calderon is related with the present study because it mentioned of the method used by the researcher. It gave the researcher insights about the similarities of the different self-pacing method.

Many studies show that learning is enhanced when students become actively involved in the learning process. Instructional strategies that engage students in the learning process stimulate critical thinking and a greater awareness of other perspectives. Although there are times when lecturing is the

most appropriate method for disseminating information, current thinking in college teaching and learning suggests that the use of a variety of instructional strategies can positively enhance student learning. Thus, Blair (2006: online) commented that the best way to think of active learning in the classroom is to focus on learning processes rather than on learning products. Active learning redefines classroom practice from a static view of learning in which knowledge is poured into the passive, empty minds of student learners to a more dynamic view where, through project-based, collaborative, and problem-based activities, students play a more vital role in creating new knowledge to be applied to other professional and academic contexts.

The literature of Blair gave the researcher ideas about what should be the active learning environment inside the classroom. She emphasized that although the learner play a more vital role in active learning, the role of the instructor is equally important. Both student and teacher should develop a more interactive relationship in active learning.

Faust and Paulson (1989) support the idea of using active learning in the classroom. Both suggested techniques which includes exercises aimed at individual students. These exercises are particularly useful in providing the instructor with feedback concerning student understanding and retention of material. They are designed to encourage student's exploration of their own attitudes and increase retention of material presented. These techniques include the one-minute paper, a highly effective technique point, affective response and

daily journal are exercises in which students are asked to answer questions or react to a particular topic to provide an emotional and evaluative response to the material.

Bonwell and Eison (1991) offer a few examples of in-class active learning techniques used in small and large classes, and with all levels of students. These techniques include think-pair-share, collaborative learning groups, student-led review sessions, games such as jeopardy and crossword puzzles, analysis or reactions to videos, student debates, mini-research proposals, analyze case studies and keeping journals or logs.

Charles C. Bonwell and James A. Eison (1991) also suggested some ways on how to incorporate active learning in the classroom. According to them, the modification of traditional lectures is one way to incorporate active learning in the classroom. Research has demonstrated, for example, that if a faculty member allows students to consolidate their notes by pausing three times for two minutes each during a lecture, students will learn significantly more information. Two other simple yet effective ways to involve students during a lecture are to insert brief demonstrations or short, ungraded writing exercises followed by class discussion. Certain alternatives to the lecture format further increase student level of engagement: 1) the feedback lecture, which consists of two minilectures separated by a small-group study session built around a study guide, and 2) the guided lecture, in which students listen to a 20- to 30-minute presentation without taking notes, followed by their writing for five minutes what they

remember and spending the remainder of the class period in small groups clarifying and elaborating the material.

The techniques suggested by Faust and Paulson and Bonwell and Eison gave an overview on how to come up with the module which uses active learning as its approach in teaching Chemistry. Moreover, it gave ideas on how to incorporate active learning in the classroom. They are related to the present study because it deals with active learning that could be used inside the classroom.

Active learning refers to techniques where students do more than simply listen to a lecture. Students are doing something including discovering, processing, and applying information. It is involving students directly and actively to the learning process itself. This means that instead of simply receiving information verbally and visually, students are receiving and participating and doing (Meyers and Jones, 1993). Thus, students should be involved in more than listening. In active learning, less emphasis is placed on transmitting information and more on developing student's skills and engaging them in activities such as reading, discussing, and writing.

According to Chickering and Gamson (1987), active learning approach involves modular instruction where students themselves are the main focus of the attention while the role of the teacher is to guide and facilitate in the learning process. This approach encourages the students to be "active learners." Analysis of the research literature states that in active learning students must read, write

and be engaged in solving problems. Most important, to be actively involved, students must engage in such higher order thinking tasks as analysis, synthesis and evaluation. Modular instruction is one approach that is proven to be effective in the learning process of the students. Students here are given the module of which he needs to read the concept and perform the given activity either in or out of the classroom. He does this in his own pace. He learns in his own style and will be on his own. The instructor facilitates learning through consultations. This considers the individual's capacity to learn, his interests, and background knowledge.

The literatures cited by Meyers et al and Chickering et al gave the researcher a good definition of active learning and what it is all about.

Mc Keachie, (1986) stressed that traditional lecture methods in which professors talk and students involve students only passively in learning. Such passive involvement generally leads to a limited retention of knowledge by students. Research indicates that by re-organizing or adapting the ways teachers' present materials to students, teachers can create an environment in which knowledge retention is significantly increased. One of the best methods is to implement the so-called active learning.

Sivan et al. (1991) as cited by Sevilay et al. (2006: online), in a study where students took an education through active learning and student-centered learning. Students' perceptions of the effectiveness of these techniques were evaluated by means of a questionnaire and interviews. Results showed an

overall contribution of the active learning approach used in tutorials to the development of students' communication and problem-solving skills as well as to their critical-thinking ability. The importance of incorporating aspects of field work into classroom learning was also highlighted.

The studies cited by Mc Keachie and Sivan have relation with the present study in the sense that both compared the effects of active learning approach in teaching with the traditional lecture methods.

The most essential characteristic of an effective teacher is his ability to provide innovative strategies and techniques. Instructional strategies that would match the needs of our students, our particular courses and our own teaching styles and personalities.

Related Studies

A number of studies undertaken that have bearing on the present study were reviewed to give more meaning and ideas on this investigation. These previous researches serve as a guide because of the similarities of this present study.

Ellado (1998) in his study entitled "Validation of Developed Instructional Materials in High School Chemistry" aimed to determined the effectiveness of the use of modules in teaching Gas Laws found out that the instructional material improve the performance of the students.

He recommended that Chemistry teachers need to upgrade in relation to their knowledge on content and teaching strategies by sending them to seminars, trainings and workshops where they will be taught how to develop and design innovative strategies and methods of teaching the subject.

The study of Ellado is similar to the present study in its intention to compare the effect of a new method to a lecture discussion method of instruction. The study of Ellado proved that the modular instruction is effective than the traditional lecture/discussion method while the present study will try to determine the effectiveness of the active learning approach in teaching. Both study utilized Chemistry as their field of specialization however they differ in the use of respondents. The respondents in the study of Ellado were high school students of Samar College while the present study will have college students of Samar State University as respondents.

Arboleras' (1999) study entitled "Validation of Instructional Module on Proportion and Variations for Mathematics III in Bagacay National High School. The results of the experiment showed that the performance of the experimental group in the posttest was significantly better than the performance in the pretest and learning the modular instruction takes place. Also, the performance of the control group in the posttest was significantly better than the performance in the pretest and that learning through lecture-discussion method took place. She concluded that the modular approach of teaching is more effective than the traditional lecture/discussion method as far as the topic Proportions and

Variations are concerned. This is true because the students could go through the module and learn its contents at their own rate, check and repeat some topics of their work if needed, discover processes and techniques to learn the lesson until the feeling of satisfaction is attained.

He further recommended that modules should be used by the students to give them chance to catch up with the lesson not well learned from classroom instruction. However, this could go hand in hand with the lecture/discussion method.

The study of Arboleras bears relationship with the present study because both are experimental in nature. The studies differ only in the field of concentration. The study of Arboleras focused on determining the effectiveness of the instructional module in teaching Mathematics III while the present study focused on determining the effectiveness of the active learning approach in teaching Chemistry 101.

Another study was conducted by Bacsal (1998) on the "Effectiveness of Workbook in Teaching Mathematics I in Calapi National High School, Calapi, Motiong, Samar found out that there was a significant difference between the mean of the pretest and posttest for both the experimental and the control group. The significant increase in the posttest scores showed that the developed workbook were effective compared to the traditional lecture/discussion method supplemented by worksheets, activity sheets and exercises. She further recommended that students should be exposed to material-centered instruction

like the use of workbooks in order to develop their potential for independent learning.

The study conducted by Bacsal is similar with the present study because both are experimental in nature and focused on material-centered instruction. However, the study of Bacsal made use of the workbook while the present study made use of the module based on the active learning approach.

Padilla (2006) study evaluated the achievement in Science and Technology in the Secondary Education Development Program (SEDP) of students in Eastern Visayas or Region VIII for SY 2004-2005. The researcher adopted the descriptive-correlational research method using survey questionnaire and documentary analysis as the main instruments in data gathering. The researcher determined: First, 1) the profile and level of performance in terms of Mean Percentage Score (MPS) in Science and Technology based on division achievement test; 2) the profile of S & T teachers in the respondent schools; 3) level of adequacy and utilization of S & T facilities as perceived by students and S & T teachers. Secondly, a comparative analysis was undertaken on: 1) student's MPS by age, year level, sex, school and division; 2) perceptions of the students and S & T teachers in the level of adequacy & utilization of S & T facilities.

The findings implied that the performance of students by school and division differed; implying differences and/or variations in the MPS could be attributed to the school where the student is enrolled as well as to the division they belong. The age and family income of the students are related to their MPS

in Science and Technology. The study further revealed that in Eastern Visayas, there is a lack of qualified S & T teachers as shown by the data on their educational background. Moreover, the S & T teacher's age, sex, civil status, teaching experience and teaching load are not related to the student's MPS in S&T. Meanwhile, the teachers' educational background, relevant trainings/seminars/conferences attended as well as average family income are related to the students MPS in Science & Technology.

The study of Padilla bears relationship with the present study because both study utilized Science & Technology as their field of specialization however they differ in the use of research methods. Padilla's study was descriptive in nature using the descriptive-correlational research method while the present study was both descriptive and experimental in nature using descriptive-developmental design and experimental method of research.

Another experimental study was also conducted by Maniable (2003) attempted to develop and evaluate an instructional module in Electricity on High School students in Tiburcio Tancinco Memorial Institute of Science & Technology. The respondents of the study were nine raters who evaluated the module in Physics particularly Electricity. Likewise the fourth year secondary laboratory students of TTMISt enrolled during SY 2002-2003 were the subjects for the try out.

The modules contained the following features: the topic, introduction, instructional objectives, readiness test, activities and evaluation. The computed

t-test between the means of the posttest scores of the experimental group and the control group is significant at 0.01 level. The computed mean which is 38.48 of the experimental group is much greater than the mean of the control group which is 27.55 with a mean difference of 6.498. The p-value of 0.000 is greater than the .01 level of significance. These result showed that there is a significant difference in the results of the two groups. The experimental group performed more than the control group. The results showed that the use of module is more effective than the traditional approach.

The study of Maniable bears relationship with the study at hand in the sense that both are experimental in nature and centered on the utilization of an instructional material. They are also similar inasmuch that both studies attempted to develop and evaluate an instructional material. They differ in the field of specialization and the use of respondents. The present study utilized Chemistry as its field of specialization and college students as respondents. Maniable's study however utilized Physics particularly Electricity as its field of specialization and high schools students as respondents.

Velasco (2002) conducted a classroom research which investigated the Effect of Modular Approach versus Conventional Approach Teaching Chemistry. The research aimed to develop and validate the self-learning modules in the two chapters of Chemistry textbooks and determine the effect of modular approach versus conventional approach in teaching Chemistry. The researcher adopted the non-equivalent control group design involving two

groups: the control group taught in conventional approach and the experimental group received the treatment which was the modular approach. The population of the research consisted of two chemistry classes in the third year Kisante High School, Cotabato Province who were composed of 51 students in the experimental group and 50 students in control group with a total of 101 students. The statistical used in the research were the t-test to determine the significant difference between pretest and posttest of both experimental and control groups.

The results and findings of this study revealed the difference in the gain scores in the posttest between two groups were found significant but the modular approach obtained higher achievement than the conventional way of teaching.

The researcher concluded that the modular approach of teaching Chemistry is more effective than the conventional approach of teaching. She therefore recommended that similar researches be conducted in the future to determine the effect of modular approach versus conventional approach of teaching involving other science subjects. Furthermore, she recommended that the acceptability of the module will also be conducted.

The study of Velasco bears relationship with the study because both aimed in determining the effectiveness of new teaching strategy and its effect compared to the conventional or traditional way of teaching Chemistry. However, the uses of respondents differ. Velasco's study used third year high

school students as respondents while the present study used first year college students as its respondents.

Tacardon (1996) as cited by Velasco (2002) in his study of the Effectiveness of Activity-Based Approach in Teaching College Algebra confirmed that the theory of self-activity is true since evidence was shown in her study that the effectiveness of the activity-based modules was found to be highly significant. The use of self-instructional module is the most significant characteristic of the learning process for learning is not merely a process of passive absorption. Learning takes place in activity and therefore the learners must do it.

Another study conducted by Yecyec (1998) to determine the effectiveness of using active learning strategies and expository method in teaching natural science to freshmen college students.

Eighty-four freshmen college students enrolled at the Notre Dame of Kidapawan College was used as subjects of the study. They comprised of four treatment groups matched based on sex and mental ability test scores. With these four groups of twenty one, three groups served as experimental and one as the control group.

The research instrument for gathering data were topical test and achievement test constructed by the researcher. t-test for correlated samples and multiple regressions were used to measure the effects of sex, IQ, and teaching strategies on the achievement of students in the topical and achievement tests. Analysis of variance was used to compare the level of achievement.

From this experiment, the researcher concluded that active learning strategies are effective in the teaching of natural science to college freshmen. Also, students exposed to active learning strategies performed better than those with the expository method. Better achievement on the part of the experimental group had some implications. In the field of natural science, learning is more effective when it is generated by the learners themselves as they are actively involved holistically both cognitively and effectively as active participants in the learning process.

The study of Yecyec is similar with the present study since both studies aimed at determining the effectiveness of using active learning strategies to college freshmen students. The studies differ in the field of concentration and the use of research instrument.

In a study conducted by Aknoğlu and Özkardeş Tandogan (2006) entitled "Effects of Problem Based Active Learning in Science Education on Student's Academic Achievement, Attitude and Concept Learning", both quantitative and qualitative research methods were utilized. Quantitative data were obtained via the pre/post-test, treatment-control groups test model. Qualitative data were obtained via document analysis. The research study was conducted on 50, seventh grade students in 2004-2005 school year, in a public school in Istanbul. The treatment process took 30 class hours in total. In the research, three measurement instruments were used: an achievement test, open-ended questions, and an attitude scale for science education. The reliability

coefficient of the achievement test was calculated to be KR20=0.78. Cronbach α value of the attitude scale was 0.89. While the subject matters were taught on the basis of problem-based active learning in the treatment group, traditional teaching methods were employed in the control group. In the face of the data collected and the evaluations made in the research, it was determined that the implementation of problem-based active learning model had positively affected students' academic achievement and their attitudes towards the science course. It was also found that the application of problem-based active learning model affects students' conceptual development positively and keeps their misconceptions at the lowest level.

The study of Akınoglu and Özkardeş Tandoğan bears relationship with the study because both are experimental in nature. Both study utilized quantitative and qualitative research methods. The studies differ in the use of respondents and the subject matter taught during experimentation. The study conducted by Akınoglu and Özkardeş Tandoğan utilized the topic "Force and Motion while the present study utilized the topic "Matter" as its subject matter applied in the experimentation.

In another study conducted by Mahajan (2005) entitled "University Students' Performance in Organic Chemistry at Undergraduate Level: Perception of Instructors from Universities in the SADC Region." The survey research methodology was used for this study. The study describes the perception of Organic Chemistry instructors from different universities in the SADC (Southern

African Development Community) region on the performance of students in this subject. The questionnaire was sent by email to Organic Chemistry instructors in the universities of the SADC region. The instructors were asked to rate the importance of fourteen statements of the questionnaire on a five-point Likert scale on which five indicated that they strongly agreed with the statement and one indicated that they strongly disagreed with the statement. The majority of instructors from the universities in SADC region who responded to the questionnaire have teaching experience of more than five years. All the instructors had PhD in Organic Chemistry. The respondents comprised of 33 percent female and 67 percent male. The findings indicated that the use of active learning methods like short exercises during lectures obtained a mean value of 4.12 for the statement. Writing promotes critical thinking and provides a method for student discovery and growth. Active learning methods during lectures such as concept tests and problem sheets have been proved to be successful in improving the grades. The instructors in the SADC region also agreed to this statement and found them useful.

Mahajan's study is similar to the present endeavor inasmuch that both deals with improving the performance of undergraduate students in Chemistry. Also, both studies include active learning approach as one of the methods of instruction that greatly improve the performance of students in Chemistry. However, it differed from the present study in terms of the research methodology used. Mahajan's study used a survey research methodology while

the present study used descriptive-developmental design and experimental design.

Irene (2009) conducted a study entitled "Computer-Assisted Instruction in Chemistry for Secondary Students: Its Implications for Instructional Redirections. The researcher sought to determine the effectiveness of computer-assisted instruction in helping high school student understand and meaningfully learn concepts in chemistry. The results of the study provided Irene to bases for concluding that "The two methods of teaching, the Computer-Assisted Instruction and the Traditional Method of Teaching "Chemical Bonding" are equal in the bases of the posttest scores of the to groups." He recommended that chemistry teachers should upgrade themselves in the recent innovations in classroom teaching. He further encourage teachers to use combined traditional & computer-assisted instruction to invoke greater enthusiasm and interest among the learner to break the monotonous mode in the classroom with the use of varied teaching methodologies in teaching Chemistry.

The study of Irene was relevant to the present endeavor inasmuch as both are experimental in nature and had the same subject area which is Chemistry. On the other hand, the previous study determined the effectiveness of a computer-assisted instruction while the present study aimed to develop and validate modules based on active learning approach in Chemistry. Both studies introduced recent innovations in classroom teaching.

A study entitled "The Effect of Simulation & Computer-Aided Instruction on the Performance in Trigonometry of Third Year High School Students of Samar State University was conducted by Baco (2006). The study determined the effect of simulation and Computer-Assisted Instruction (CAI) on the performance in Trigonometry of Third Year High School students of Samar State University. The researcher utilized the pretest-posttest multi-group experimental design using three different methods of teaching Trigonometry specifically "Solutions of Right Triangle" as the independent or treatment variable and the pretest and posttest scores as the dependent variable. It was concluded that the three methods of teaching namely the simulation, computer-assisted instruction and lecture-discussion were equally effective methods especially in teaching topic solutions of right triangle to third year high school students. She further concluded that the age, sex, average family income per month, frequency of study, time of study, location of study and study practices had nothing to do with the posttest scores of the subjects.

The study of Baco proved to be similar to the present study in the sense that they ventured on determining the effectiveness of a new method of teaching against the Traditional Lecture-Discussion Method. The previous study determined the effect of simulation and computer-assisted instruction while the present study determined the effectiveness of Modules based on active learning approach in teaching. However, Baco involved high school students while the

present study involved college students. Meanwhile, Baco's subject area was Mathematics while this was on Chemistry.

The related studies just cited were pertinent and relevant to the present study pursued. It gave substantial evidence and reason for the researcher to believe that active learning approach in teaching Chemistry enhanced student's performance. The researcher undertook this study hoping to encourage teachers to adopt current teaching innovations including a more student-centered active learning approach both to teaching and course material. Hence, this study was conducted.

Chapter 3

METHODOLOGY

This chapter presents the research design, instrumentation, validation of the instrument, sampling procedure, data gathering procedure and statistical treatment of data that were employed in this study.

Research Design

This study employed two research designs. The descriptive-developmental design was used during the development stage using the Interest Inventory as its instrument. It aimed at determining what topics in Chemistry 101 can be developed as materials for active learning approach. The result of the Interest Inventory became the basis of the development of the materials for active learning approach in Chemistry. In the validation stage, the experimental method of research was employed in this study using randomized pretest and posttest design. The study consisted of 60 students as respondents that were divided into two groups namely: the control group and the experimental group. Thirty students comprised the control group were subjected to the traditional lecture-discussion method. The other 30 students were taught in an active learning approach of instruction.

The experimental design (Herrin, 1987: 39) of the study is shown below.

R	O ₁₁		O ₁₂
		X	
R	O ₂₁		O ₂₂

where:

- O₁₁ refers to the pretest administered to the experimental group;
- O₂₁ refers to the pretest administered to the control group;
- O₁₂ refers to the posttest administered to the experimental group;
- O₂₂ refers to the posttest administered to the control group;
- X refers to the treatment, in this case the use of the modules in teaching Chemistry 101, and
- R refers to the randomization procedure used in selecting study units.

The pretest and posttest were administered to both control and experimental groups. The performance of students in both pretest and posttest was compared statistically as shown in the research design to determine the difference of performance of both groups which eventually reveal the effectiveness of the experimental intervention.

Instrumentation

The instruments utilized in gathering data in this study were the following:

Interest inventory. The researcher prepared an Interest Inventory to find out what topics in Chemistry 101 can be developed as modules for active

learning approach in teaching. It was personally checked and validated by her adviser. The inventory consisted of 20 positive statements in a five-point Likert scale. It was administered to BSIM second year students of Samar State University Main Campus.

Documentary analysis. The researcher obtained the data on general average grade in their high school from DECS Form 137 or Permanent Record of the Student. This form was requested by the researcher from the Registrar's Office. Meanwhile, the age, birthday, family source of income was taken through a checklist prepared by the researcher in the form of a questionnaire for the subjects to answer and affix their age, address, birthday, family source of income and their average family income per month. On the last item, the researcher told the students to let their parents be the ones to give the data. Scrutiny and checking of the records were followed.

Evaluation sheet. The modules on matter were evaluated through the data gathered from an evaluation sheet. The instrument used was derived from a related study (Irene, 2003) and was already validated. As a result, the experimental group gave a favorable evaluation in the materials used in the study.

Pretest/posttest. The pretest and posttest were administered to both the experimental and control group. It covers the topic on matter that was taught on the experimentation. The researcher prepared the initial draft of the pretest/posttest. A table of specification was prepared based on the syllabus in

Chemistry 101(Chemistry of Metals) to insure content validity. It was scrutinized by her adviser for further improvement and make judgment on the representativeness and relevance of the entries made in the Table of Specification. Then, it was tried out to second year students of BSIM of Samar State University, Catbalogan, Samar. After the item analysis of the test, a 30-item was developed. The pretest was administered last June 10, 2008 and the posttest was administered June 27, 2008 after the experimentation.

Validation of the Instrument

The researcher undertook expert-validation of the instruments used in the study.

Pretest/posttest. Initially, a 65-item test was constructed based on the Table of Specifications prepared using knowledge, comprehension, application and higher application type of cognitive abilities. Upon completion of the test, the researcher consulted her fellow instructors and professors at Samar State University for their comments, suggestions, and corrections for the improvement of the test. All suggestions were incorporated, after which the researcher administered the pretest and posttest to second year BSIM students of Samar State University who have already taken Chemistry in their previous year.

The test instrument was subjected to analysis for facility values and discrimination indices. The facility values, which determine whether an item should be retained or rejected, ranged from 0.13 to 0.9. Discrimination indices,

which determine discriminating power of an item, on the other hand, had values ranging from -0.25 to 0.5. Based on the data of the facilities values, the original test instrument was composed of 14 very difficult items, 41 medium difficult items and 10 medium easy items. The formula of Bright (1979: 17) was used in calculating the facility value and index of discrimination.

Out of the original 65-item test, it was trimmed down to 30 items due to low discrimination indices. Items with discrimination index of 0.2 or higher were retained while those lower than 0.2 were rejected. Discrimination indices of the retained items ranged from 0.2 to 0.5 while facility values of them ranged from 0.2 to 0.9. The improved test consisted of 5 very difficult items, 22 medium difficult items and three medium easy items.

The Kuder-Richardson formula 21 (Fraenkel, 1993: 149) was applied to determine the reliability of the test instrument wherein the data used was the scores of the students who participated in the try-out. The test reliability coefficient was computed to be 0.73, which is acceptable for research purposes. Thus, the test instrument was reliable for the study.

The improved test instrument was composed of medium difficult items as reflected by its computed mean facility value of 0.50. Meanwhile, the computed discrimination index mean of 0.33 implied the test was made up of very good items.

Inventory. The interest inventory was constructed to identify what topics in Chemistry 101 can be developed as modules for active learning approach.

Initially, the researcher constructed 50 positive statements in a five-point Likert scale. Some of the items were quoted from the instrument used in a related study (Irene, 2003) but were just improved to suit the study. The statements were based on the topics in a syllabus in Chemistry 101 to insure content validity. It was personally checked by the adviser and colleagues for their comments and suggestions for improvement. Incorporating their suggestions, the instrument was tried out to 65 BS Information Technology second year college students of SSU, Catbalogan City, Samar who have already took Chemistry 101. Their scores obtained were item analyzed using the formula by Edwards (1957: 152).

The statements were arranged according to their calculated t values from the highest to lowest. Statements with the t-value or greater than 1.75 were retained. Hence, out of 50 statements, the interest inventory was trimmed down to 30 statements.

Modules. On the evaluation of the modules used in the study, the following procedure was followed in the production of the module (Amonceda, 2001):

Stage 1 is the development of active learning materials for the topic matter. This stage was result to the production of the materials. In developing the material, four stages were undertaken, namely: the design, construction, validation and revision. In the design stage, an interest inventory was constructed to determine which topic in Chemistry would likely interest students

to do activities using the active learning approach. The result of the Interest Inventory was the topic "matter." The construction stage involves the actual writing of the material and construction of the pretest/posttest. After writing the material, the Table of Specifications (TOS) was prepared which was the basis for the construction of the pretest/posttest. The learning program of the module was planned out and prepared based on the task analysis chart. Activities included for students' task were taken from some Chemistry books. Some modifications were made to suit the needs of the students' level and also the objectives of the module. This will facilitate better understanding of the contents of the particular material.

The validation stage, chemistry teachers and a number of chemistry major students were asked to examine the constructed active learning material and the prepared pretest/posttest. The students were asked to look into the physical features of the materials like figures, tables, etc, and the clarity of the presentation of the lesson. In the revision stage, the materials were revised according to the assessment procedures employed during the validation stage. As much as possible, students were not allowed to use invalidated module to minimize errors in the concepts.

The assessment and validation of the module was done with the use of the following:

A. Questionnaire/ Checklist

The frequency of the teachers' and students' responses to the questions asked was recorded.

B. Feedback-based Readability Formula

This was based on the reader's perception on the clarity of the material (Talisayon, 1983).

Stage 2 is the module was used and evaluated by the experimental group. The main purpose of the evaluation is to test the effectiveness of the modules as a self-instructional material in the modularized instruction inside and outside of the classroom.

The evaluation consists of two parts. The first part was the try-out of the active learning materials. This determines the effectiveness of the material. This part was based on the premise that if the use of material is effective, then the students who used them is expected to perform significantly better than those who did not (pretest and posttest). The second part was the evaluation of the material based on the students' judgment as to the physical features of the material as well as its content and vocabulary. Questionnaires was used in the validation stage were same questionnaires in the evaluation stage. After these procedures, the active learning modules were now ready for use.

The essential parts of the material include the following:

a. Introduction/overview. This gives the idea on what the student expects to learn from the active learning material. This may take the form of the

rationale, or just an introduction. This usually includes the importance of a module and how this relates to the condition in the environment.

b. Pretest. This may include a 10-item multiple-choice test that is self-administered and self-corrected. It is intended to find out if the student is ready to perform the following prepared tasks.

c. Objectives. These state what the student should be able to do after the completion of the module.

d. Learning resources. To attain the objectives formulated, a list of references such as books, magazines, newspapers, other media of instruction like tapes and projected visuals are provided.

e. Learning activities or study guides. Refer to what the students will do such as performing an experiment or doing an activity, solving problems and making an outdoor observation.

f. Enrichment activities. These are optional activities provided for students who may be interested in pursuing the concepts further or for the development of more sophisticated skills.

g. Self-evaluation exercise. This is given every end of each activity. This intends to find out if the objectives set for a particular activity have been realized.

h. Posttest. This is the test taken after the completion of the learning tasks in the active learning material.

Evaluation sheet. The modules on matter were evaluated through the data gathered from an evaluation sheet. The instrument used was derived from a related study (Irene, 2003) and was already validated. As a result, the experimental group gave a favorable evaluation in the materials used in the study.

Sampling Procedure

Sixty first year Bachelor of Science in Information Technology students of Samar State University were chosen through random assignment of the two sections of BS InfoTech. BS InfoTech 1A was assigned as the experimental group while BS in Information Technology 1B as the control group. In the selection of the students as to who will compose the experimental and control group, group matching was done on the four mentioned variates namely the age, sex, family monthly income and scholastic performance in high school inasmuch as individual matching/pairing of the subjects cannot be realized. They were paired off according to their entry of behavior to reduce bias. All 92 students were made to participate in the experimentation but only sixty students were included in the study. Hence, 30 students comprised the experimental group and the same number comprised the control group.

Data Gathering Procedure

The researcher asks permission to the university president of Samar State University to allow her to conduct her research at the main campus utilizing First

Year BS InfoTech students for SY 2008-2009 for the experimentation. Beforehand, the researcher had already conducted an Interest Inventory and validation of the pretest and posttest of the study to selected Second Year BSIM students with the permission of the Dean of College of Arts & Sciences. The Interest Inventory results showed that the topic "Matter" was favorable to the subjects and became the basis in the development of modules for active learning approach. The researcher personally handled the experimentation so the researcher can observe the behavior and attitude of the subjects in the experimental and control group. The attendance was also noted and no absences were noted from the members of the experimental and control group.

The profile on age, sex, and scholastic performance in high school was obtained through documentary analysis using DECS Form 137 or the Permanent Record. Meanwhile, the student's average monthly income and the level of interest in Chemistry were obtained from questionnaires. This was done prior to the experimentation.

In the gathering procedure, the researcher made sure that lighting, ventilation and other factors that may affect the scores of the students other than their knowledge on the subject matter were controlled if not minimized. The data gathered came from three experimental phases namely: 1) pre-experimentation phase; 2) experimental phase, and 3) post-experimental phase.

Pre-experimental phase. A pretest was administered personally by the researcher to the two sections of First Year students of BS Information

Technology presently enrolled at Samar State University last June 10, 2008. This was done to ensure that extraneous factors are considered and taken care of. The researcher involved all the students and just marked those that belong to the experimental group and control group. Further, the students were informed that the test is part of unit test so they would not know that they are undertaking a study. The test was done one hour after, starting from 9:00 AM to 10:00 AM and 4:00 PM to 5:00 PM for the experimental group and control group, respectively.

Experimentation phase. The experimentation was conducted starting June 11, 2008 to June 27, 2008 for a total of 12 sessions undertaken. The topic Matter was taught to the experimental group with the use of the developed active learning materials while the control group was taught the same topic using lecture-discussion or traditional method. The researcher personally handled the two groups of students to minimize Hawthorne effects. The quizzes and absences was noted and recorded.

The chemistry class period for the experimental group was from 9:00 AM to 11:00 AM during Mondays and Wednesdays and 9:00 AM to 10:00 AM during Fridays while the control group had the lecture at 4:00 PM to 5:00 PM during Tuesday and Thursday and 2:00 PM to 5:00 PM during Saturdays. The researcher made sure that extraneous factors that would affect the performance of the students during the conduct of the experiment were controlled or minimized.

The active learning materials used in the study was evaluated by the experimental group by answering a questionnaire adapted from a related study but was improved to suit the material evaluated. This same questionnaire was personally validated by the adviser.

Post-experimental phase. After the experiment, the two groups of subjects were administered with a posttest. This is the same pretest but in different arrangement of items. This was administered personally by the researcher last June 27, 2008 to ensure the validity of the results obtained. Statistical treatment was done using t-test for dependent samples for the pretest and posttest results of each group and t-test for independent sample for the posttest results of the two groups in order to determine the achievement of the two groups of respondents and the difference in their achievements.

Statistical Treatment of Data

The statistical tools used in this study were the mean, Flesch Formula, t-test for independent samples, t-test for dependent samples, facility value and discrimination indices and Flesch Formula.

Facility value and discrimination indices. The facility values, which determine whether an item should be retained or rejected, ranged from 0.13 to 0.9. Discrimination indices, which determine discriminating power of an item, on the other hand, had values ranging from -0.25 to 0.5. The formula are as follows (Bright, 1979: 17):

$$\text{Facility Value} = \frac{\text{Total no. making the correct choice}}{\text{Total no. of examinees}}$$

And the interpretation is as follows:

Very easy	=	Above 0.9
Medium easy	=	0.7 - 0.9
Medium difficult	=	0.3 - 0.69
Very difficult	=	Below 0.3

The formula for the index of discrimination:

$$\text{Index of Discrimination, ID,} = \frac{\frac{\text{No. of upper group correct} - \text{No. of lower group correct}}{\text{Total no. students in one group}}}{}$$

The value of ID and acceptability of item is summarized as follows:

<u>Value of ID</u>	<u>Acceptability of Item</u>
0.40 and above	A high level of discrimination. Retain the item.
0.30 to 0.39	Item discriminates reasonably well. Retain the item.
0.20 to 0.29	A marginal level of discrimination. Retain the item.
Below 0.2	Item does not contribute to the overall pattern of the examination results. Reject the item.
Negative values	Reject the item.

Flesch formula. To determine whether the developed modules are appropriate to the first year college students, the Flesch Formula was used. To measure the Reading Ease Score (RES) and the Human Interest Score (HIS) of the module, the following steps were undertaken (Lacambra, 1985:29):

1. Choosing the sample pages. The sample will be selected based on the total number of pages of the developed material in Chemistry 101. Exercises, answers to exercises and title page will not be included. If the sample fell on the page without reading, the next page will be considered.

2. Counting the number of words. One hundred words will be taken from each page of the first word of the first paragraph up to the 100th words. In samples where there are no paragraphs, the first word of the sentence will be considered. Figure caption, heading of lessons, number and title will not be included in the counting.

3. Counting the number of sentences. The total number of sentences in the 100th words in each sample will be counted. If the 100th word fell after more than one-half of the words of the sentence, it is counted as one. Otherwise, it will not be included.

4. Counting the number of syllables. The syllables in the 100th words in each sample will be counted. The syllables are counted the way the word is pronounced.

5. Finding the average word length. The average word length, the number of syllables in all sample pages will be divided by the total number of sample pages.

6. Finding the average sentence length. The average sentence length is the number of sentences in all the samples which will be divided by the total number of pages.

7. Solving the reading ease score (RES). The formula is shown below:

$$(RES) = 206.835 - (1.015 \times \text{Ave. sentence length} + 0.84 \times \text{Ave. word})$$

where:

$$\text{Ave. sentence length} = \frac{\text{No. of sentences in the samples}}{\text{Total no. of sample pages}}$$

$$\text{Ave. word length} = \frac{\text{No. of syllables in all pages}}{\text{Total no. of sample pages}}$$

8. Solving for human-interest score (HIS). The formula is:

$$(HIS) = (\% \text{ Personal words} / 100 \text{ words} \times 3.635) + (\% \text{ Personal Sentence} \times 0.314)$$

where:

$$\% \text{ Personal Word} = \frac{\text{Total no. of personal words in all samples}}{\text{Total no. of words in all sample pages}}$$

$$\% \text{ Personal Sentence} = \frac{\text{Total no. Personal Sentences}}{\text{Total sentences in all sample pages}}$$

For the interpretation of the RES and HIS, the following guide was used:

Interpretation of the RES and HIS

<u>Reading Ease Score (RES)</u>	<u>Correlated Grade Level</u>
90-100	5 th grade
80-90	6 th grade
70-80	1 st - 2 nd (high school)
60-70	3 rd - 4 th (high school)
50-60	1 st - 2 nd (college)
30-50	3 rd - 4 th (college)
0-30	graduate students

<u>Human Interest Score (HIS)</u>	<u>Description</u>
60-100	Extremely Interesting
40-60	Highly Interesting
20-40	Interesting
10-20	Mildly Interesting
0-10	Dull

Frequency count. This was used to analyze the subject's profile such as age, sex, scholastic performance in high school and average family income per month.

Kuder-Richardson formula 21. This statistical tool was applied to determine the reliability of the test instrument wherein the data used was the scores of the students who participated in the try-out. The formula is as follows (Fraenkel, 1993: 149):

$$\text{KR21 reliability coefficient} = \frac{K}{K - 1} \left[1 - \frac{M(K - M)}{K(SD)^2} \right]$$

where:

- K refers to the number of items in the test
- M refers to the mean of the set of test scores; and
- SD refers to the standard deviation of the set of test scores.

Mean. A measure of central location used in this study to find the "average" age, average grade in high school and family income per month.

t-test for independent samples. This was the statistical tool used to test the difference between the mean scores of the experimental and control per pretest and posttest (Walpole, 1982: 311).

t-test for dependent samples. To determine whether there was learning or none that took place in each group; the performance of each group prior and after the experimentation was evaluated making use of the t-test for dependent samples (Freund & Simon, 1992: 327).

Chapter 4

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

This chapter presents the analysis and interpretation of data gathered through the use of documentary analysis, questionnaires, pretest and posttest. The data presented consist of the subjects' profile according to age, sex, scholastic performance in high school and average family income, and their pretest and posttest results.

Profile of the Subjects

This section presents the profile of the subjects according to age, sex, scholastic performance in high school and average family income per month.

There were 60 first year college students who were involved as the subjects of the study. Of this number, 30 students belong to the experimental group and the other 30 students belong to the control group. The students in the experimental group were exposed to active learning approach in teaching Chemistry 101 while the students in the control group were taught the traditional lecture-discussion method. The lesson discussed during the experimentation was Matter.

Age. As reflected in Table 1, majority of the subjects were 16 years old. For the experimental group, the distribution is as follows: eleven or 36.67 percent were 16 years old, three or 10 percent was aged 15 1/2, five or 16.67

percent for 16 1/2 years old, seven or 23.33 percent were 17 years old and four or 13.33 percent who were 17 1/2 years old. In the control group, there were eleven or 36.67 percent who were 16 years old, three or 10 percent who were aged 15 1/2 years old , eight or 26.67 percent who were 16 1/2 years old and four or 13.33 percent for both aged 17 and 17 1/2 years old. The mean of the experimental group was 16.47 years while the mean of the control group was 16.42 years, which indicated an equality of the two groups in the entry behavior in terms of age.

Table 1
Age Distribution of the Subjects

Age	Experimental Group		Control Group	
	f	Percent	F	Percent
15 1/2	3	10.00	3	10.00
16	1	36.67	11	36.67
16 1/2	5	16.67	8	26.67
17	7	23.33	4	13.33
17 1/2	4	13.33	4	13.33
Total	30	100.00	30	100.00
Mean	16.47 yrs		16.42 yrs	
SD	0.63 yr		0.60 yr	

Sex. Table 2 displays the frequency distribution according to sex of the subjects of the study. As shown in the table, majority of the groups were females inasmuch as out of 30, 20 are females or 66.67 percent and only 10 are males of 33.33 percent of the group. Moreover, there were an equal number of subjects in the study where both groups had 30 each. The subjects were chosen through random sampling procedure and grouping through tossing of coin where BSIT 1A came out as the experimental group while BSIT 1B as the control group.

Table 2
Sex Distribution of the Subjects

Sex	Experimental Group		Control Group	
	f	Percent	f	Percent
Male	10	33.33	10	33.33
Female	20	66.67	20	66.67
Total	30	100.00	30	100.00

Scholastic performance in high school. The scholastic performances of the subjects are shown in Table 3. These were the average ratings of the subjects

Table 3
Scholastic Performance in High School of the Subjects

Experimental Group		Control Group	
Student No.	Grade	Student No.	Grade
1	85.56	1	80.81
2	83.33	2	85.65
3	83.24	3	87.02
4	82.54	4	86.20
5	88.10	5	85.90
6	87.15	6	85.15
7	90.02	7	83.05
8	85.11	8	84.04
9	86.10	9	86.26
10	85.24	10	82.56
11	85.14	11	83.50
12	82.90	12	87.10
13	86.38	13	88.70
14	83.82	14	84.35
15	86.32	15	84.01
16	88.96	16	85.35
17	85.00	17	82.45
18	85.25	18	85.31
19	83.24	19	84.41
20	82.91	20	85.20
21	86.38	21	86.03
22	82.91	22	83.30
23	89.09	23	83.75
24	82.12	24	81.36
25	83.01	25	84.04
26	90.99	26	83.01
27	86.56	27	82.78
28	84.23	28	88.40
29	82.00	29	81.25
30	83.82	30	89.56
Total	8557.42	Total	100.00
Mean	85.25	Mean	84.68
SD	2.41	SD	2.18

in their fourth year secondary. As shown in the table, 50 percent of the subjects have grades below the mean and the other 50 percent have grades above the mean. Thus, there was an equal distribution of the subjects in both experimental and control groups. The highest grade obtained by the students in the experimental group was 90.99 and the lowest grade was 82.00 and pegged an average grade of 85.25. Meanwhile for the control group, the highest grade was 89.56 and the lowest grade was 80.81 and posted an average grade of 84.68.

The data on the scholastic performance of the subjects implied that the performance of the experimental and control groups was both satisfactory.

Average family income. Table 4 depicts the average family income per month of the students. It can be gleaned from the table that majority of the subjects in both groups had a monthly family earnings greater than PhP6,000.00 as shown by 25 or 83.33 percent in the experimental group and 23 or 76.67 percent in the control group. The highest income posted in the experimental group was PhP39,000.00 and the lowest income was PhP4,500.00. Meanwhile, the control group pegged an amount of PhP32,000.00 as the highest income while PhP5,000.00 was the lowest. The means were PhP11,879.33 and PhP11,250.00 in the experimental and control group, respectively. Comparing these values with the poverty threshold of NEDA which is at PhP10,804.00 for the Province of Samar in the year 2005. This indicates that the family income of these groups show that their families can afford to provide the basic needs of

Table 4
Average Family Income of the Subjects

Experimental Group		Control Group	
Student No.	Income (in PhP)	Student No.	Income (in PhP)
1	8,500.00	1	24,400.00
2	9,000.00	2	15,000.00
3	8,500.00	3	12,000.00
4	5,800.00	4	6,000.00
5	16,500.00	5	9,500.00
6	6,800.00	6	5,800.00
7	39,000.00	7	8,800.00
8	10,800.00	8	5,500.00
9	5,000.00	9	8,000.00
10	8,500.00	10	28,200.00
11	8,000.00	11	6,500.00
12	15,200.00	12	5,000.00
13	20,500.00	13	10,000.00
14	16,800.00	14	8,000.00
15	8,000.00	15	29,500.00
16	9,500.00	16	6,500.00
17	9,500.00	17	8,800.00
18	21,800.00	18	7,200.00
19	18,800.00	19	32,000.00
20	11,300.00	20	6,500.00
21	7,500.00	21	16,500.00
22	8,000.00	22	10,000.00
23	10,000.00	23	5,000.00
24	9,500.00	24	15,800.00
25	12,280.00	25	8,500.00
26	9,500.00	26	8,500.00
27	6,500.00	27	7,500.00
28	15,800.00	28	5,500.00
29	10,000.00	29	12,000.00
30	9,500.00	30	5,000.00
Total	356,380.00	Total	337,500.00
Mean	11,879.33	Mean	11,250.00
SD	6,723.73	SD	7,612.32

their family members like food, clothing, shelter and education. Also, according to NEDA in an average family size of five, a family monthly income of PhP4,010.00 is considered to be non-poor. Hence, none of the respondents can be considered as poor.

Level of Interest of the Students in Chemistry 101

Table 5 shows the level of interest of the students in Chemistry 101. The subjects pegged the highest mean of 4.48 on which they strongly agree on the statement that they can relate scientific method in solving problems and do activity related to it. It was followed by a mean of 4.43 or "agree" which referred to the statement that the subjects love to do experiments related to solid, liquid and gas. The third highest mean of 4.37 signified agree to the statement that the subjects can easily classify matter into elements, compounds and mixtures. The lowest mean was 2.60, on the other hand, signified uncertain on the statement "I find it easy to predict molecular geometry in terms of VSEPR." The next lowest mean was 3.05 signified that they agree on the statement they find Hund's Rule, spin quantum number and Pauli Exclusion Principle interesting and meaningful.

The three highest mean of the interest inventory falls on the topic "Matter." This indicates that the students are more interested on this topic and are likely to do activities related to it. Hence, the topic "Matter" was developed as modules for active learning approach in teaching Chemistry 101. Moreover,

Table 5
Level of Interest of the Subjects in Chemistry 101

STATEMENTS		Mean/ Interpretation	Rank
1.	I am interested in knowing how Chemistry develops and its importance to our daily life.	4.32	A 6
2.	I can relate the scientific method in solving problems and do activity related to it.	4.48	A 1
3.	I can easily classify matter into elements, compounds and mixtures.	4.37	A 3
4.	I love memorizing the symbols of elements and chemical formulas of compounds.	4.33	A 5
5.	I find it easy to differentiate between physical and chemical properties and changes in matter.	4.22	A 8
6.	I am interested to know how atoms, molecules and ions differ.	4.34	A 4
7.	In find interesting it and enjoyable in identifying the atomic number and mass number of sub-atomic particles.	3.80	A 16
8.	I am interested on how the number of orbital and the maximum number of electrons relate to each other.	3.53	A 22
9.	I find Hund's Rule, spin quantum no. and Pauli Exclusion Principle interesting.	3.05	U 29
10.	I am interested on how the periodic table is set up.	4.02	A 11
11.	I find it easy to classify elements into representative elements, noble gases, transition metals and inner transition metals using the periodic table.	3.76	A 19
12.	I am interested on how the elements are divided into periods, groups, and families.	3.06	U 28
13.	I find it interesting to predict periodic variations in metallic properties, atomic size, ionization energy, electron affinity and electro negativity using periodic table.	3.84	A 13
14.	I like writing the correct names and formulas of binary compounds, bases, oxyacids and salts.	3.83	A 14.5

Table 5 *continued*

	STATEMENTS	Mean/ Interpretation	Rank
15.	I am interested on how ionic bond and covalent bond are formed.	4.04	A 10
16.	I like the topics in bonding because they are interesting and easy.	4.11	A 9
17.	I can relate to the bonding concept to the company of my friends and classmates.	3.65	A 21
18.	I enjoy drawing Lewis structures for molecules and its resonance forms.	3.42	U 25
19.	I find it easy to predict molecular geometry in terms of VSEPR.	2.60	U 30
20.	I find balancing chemical equation enjoyable.	3.95	A 12
21.	I appreciate the significance of knowing how to read and write formulas when working in the laboratory.	4.30	A 7
22.	I find the lesson in thermochemistry enjoyable and interesting.	3.75	A 20
23.	I enjoy doing stoichiometric calculations involving heat transfer from thermochemical equations.	3.23	U 26.5
24.	I like the topic on enthalpy, entropy, and its relation to total energy change.	3.43	U 24
25.	I find it interesting on how calorimeter works.	3.50	U 23
26.	I like to discuss the principles of First and Second Law of Thermodynamics.	3.23	U 26.5
27.	I like doing calculations involving relationships between volume and pressure, volume and temperature and temperature and pressure.	3.78	A 17.5
28.	I enjoy doing experiments about Kinetic Molecular Theory as applied to gases.	3.83	A 14.5
29.	I love to do experiments related to solid, liquid and gas.	4.43	A 2
30.	I am interested on how solutions differ from colloid.	3.78	A 17.5
Grand Mean		3.80	A
Interpretation		Favorable	

Legend: 4.51 - 5.00 Strongly Agree (SA)/Very Favorable

3.51 - 4.50 Agree (A)/Favorable	1.51 - 2.50 Disagree (D)/Unfavorable
2.51 - 3.50 Uncertain (U)/Neutral	1.00 - 1.50 Strongly Disagree (SD)/Very Unfavorable

the grand mean of 3.80 showed a favorable interest of the student- respondents in chemistry insofar as the topic matter is concerned.

Readability Level of the Module

Before the start of the experiment, the developed active learning materials were tested in terms of the readability by getting a random sample of 30 pages. To compute the Reading Ease Score (RES) and Human Interest Score (HIS), the total number of words, personal words, syllables, personal sentences for these pages were counted by the researcher. The results are reflected in Table 6.

Table 6
Reliability Level of the Module

Indicator	Value	Interpretation
Average Word Length	97.2	-
Average Sentence Length	72.9	-
% personal words	4.94%	-
% personal sentences	57.81%	-
Reading Ease Score (RES)	50.62	1 st to 2 nd (College)
Human Interest Score (HIS)	36.13	Interesting

As revealed in the table, the average word length was 97.2 syllables per page, while the average sentence length was 72.9 words per page. Meanwhile, approximately 4.947 percent of the total words were personal words like the use of I, you, yourself and me and 57.81 percent of the total sentences in the sample

pages were sentences that contained personal sentences. Consequently, the computed Reading Ease Score (RES) was 50.62 which meant that the readability of the active learning materials were appropriate for the first year to second year college students. Moreover, the Human Interest Score (HIS) was posted at 36.13 which classified the materials to be at an "interesting level."

The aforementioned data implied that the developed active learning materials were appropriate to the target group of the study, the first year college students and that the active learning materials are interesting.

Pretest Results of the Experimental and Control Groups

Table 7 displays the pretest scores of the subjects in the experimental and control groups. The highest score obtained by the experimental group was 21 while that of the control group was 20. Both the experimental and the control group obtained a lowest score of eight. Overall, the experimental group obtained a score of 392 with a mean of 13.07. When the t-test of independent samples was employed, the result was that the computed t of 0.42 was lesser than the tabulated t which were 1.67 for one-tail and 2.00 for two-tail at $\alpha=0.05$ level of significance and 58 degrees of freedom. This result showed that the first null hypothesis, which stated that "There is no significant difference in the pretest mean scores of the control and the experimental group," was accepted. The result implied that the experimental and control group have the same level of performance prior to experimentation.

Table 7

Pretest Scores of the Experimental and Control Groups

Student No.	Pretest Scores	
	Experimental Group	Control Group
1	14	15
2	9	13
3	11	11
4	16	14
5	17	15
6	9	14
7	14	13
8	14	13
9	16	9
10	16	13
11	7	17
12	13	15
13	8	15
14	15	11
15	10	13
16	11	20
17	12	18
18	12	12
19	16	13
20	16	16
21	14	11
22	14	10
23	13	16
24	10	16
25	10	13
26	19	9
27	10	13
28	21	14
29	9	12
30	16	8
Total	392	402
Mean	13.07	13.4
SD	3.39	2.65
Computed t	0.42	
Critical t at $\alpha = 0.05$ & df = 58	1.67	
Evaluation/Decision	Not Significant/Accept H_0	

Pretest and Posttest Scores of the Control Group

The pretest and posttest scores of the control group are shown in Table 8. As shown in the table, four or 13.33 percent of the subjects got a score in the posttest lower than their scores in the pretest while one got a score in the pretest the same in the posttest. Meanwhile, 25 or 83.33 percent of the subjects obtained an increase in their posttest scores. The highest score in the pretest was 24 while the lowest was 8 while in the posttest, the highest score obtained in the control group was 24 and the lowest was 11. The subjects in the pretest and posttest obtained a total score of 402 and 528, respectively. The sample means obtained in the pretest and posttest were 13.40 and 17.60, respectively. The standard deviation in the pretest was 2.70 while in the posttest was 2.84. The t-test for dependent samples was employed to find out if significant difference existed between the two sets of data. The computed t which was 5.86 was proved to be higher than the tabulated t of 2.05 at α 0.05 and 29 degrees of freedom. Thus the hypothesis that "There is no significant difference between the pretest and posttest mean scores of the control group" was rejected. This result implies that the use of traditional method in teaching Matter is also effective.

Table 8
Pretest and Posttest Scores of the Control Group

Student No.	Scores	
	Pretest	Posttest
1	15	16
2	13	18
3	11	20
4	14	18
5	15	17
6	14	20
7	13	21
8	13	20
9	9	21
10	13	15
11	17	16
12	15	16
13	15	16
14	11	18
15	13	14
16	20	17
17	18	24
18	12	11
19	13	18
20	16	18
21	11	17
22	10	19
23	16	16
24	16	14
25	13	17
26	9	16
27	13	24
28	14	16
29	12	20
30	8	15
Total	402	528
Mean	13.4	17.6
SD	2.7	2.84
Computed t	5.86	
Critical t at $\alpha = 0.05$ & $df = 28$	2.05	
Evaluation/Decision	Significant/Reject H_0	

Pretest and Posttest Results of the Experimental Group

Table 9 presents the pretest and posttest scores of the experimental group. As can be gleaned from said table, 26 or 86.67 percent of the subjects obtained scores in the posttest greater than in the pretest. Two subjects had their scores the same with their scores in the pretest while the other two had scores decreased in the posttest. The highest score in the pretest was 21 and the lowest score was seven while in the posttest, the highest score in the experimental group was 26 and lowest was 12. The total score in the pretest was 392 while the total score in the posttest was 563. The means in the pretest and posttest were 13.07 and 18.77, respectively. The standard deviation obtained by the subjects in the pretest was 3.39 while the posttest was 3.50. The t-test for dependent samples was employed to find if significant difference existed between the two sets of data. The computed t which was 7.94 was proved to be higher than the tabulated t of 2.05 at $\alpha = 0.05$ and 29 degrees of freedom. Thus, the result hypothesis that "There is no significant difference between the pretest and posttest mean scores of the experimental group" was rejected. Thus, the subjects in the experimental group also gained marked improvement after they were taught using the active learning approach in chemistry.

Table 9
Pretest and Posttest Scores of the Experimental Group

Student No.	Scores	
	Pretest	Posttest
1	14	19
2	9	16
3	11	15
4	16	19
5	17	21
6	9	26
7	14	18
8	14	12
9	16	20
10	16	19
11	7	15
12	13	20
13	8	12
14	15	20
15	10	19
16	11	21
17	12	21
18	12	19
19	16	16
20	16	22
21	14	26
22	14	14
23	13	22
24	10	15
25	10	19
26	19	23
27	10	19
28	21	21
29	9	15
30	16	19
Total	392	563
Mean	13.07	18.77
SD	3.39	3.50
Computed t	7.94	
Critical t at $\alpha = 0.05$ & df = 28	2.05	
Evaluation/Decision	Significant/Reject H₀	

Posttest Results of the Experimental and the Control Group

Table 10 shows the posttest scores of the subjects comprising the experimental and control groups. The experimental group obtained a highest score of 26 and the lowest score of 12 while in the control group; the highest score obtained was 24 and the lowest score of 11. In the experimental group, the total score was 563 and a mean of 18.77 while the total score in the control group was 528 and the mean was 17.60. When t-test for independent samples was employed, the result was that the computed t of 1.42 was lesser than the tabulated data which were 1.67 for one-tail and 2.00 for two-tail at $\alpha = 0.05$ and 58 degrees of freedom. This result implied that the hypothesis, which stated that "There is no significant difference between the posttest mean scores of the control and the experimental group," was accepted. The numerical difference of 1.17 of the mean scores proved to be insignificant implying the two approaches in teaching chemistry, that is, the active learning approach and traditional lecture discussion method are at par in terms of teaching the topic "Matter."

Evaluation of Module by the Experimental Group

Table 11 shows the evaluation of the respondents in the experimental group on the active learning material used in the study. As depicted by the table,

Table 10
Posttest Scores of the Experimental and Control Group

Student No.	Scores	
	Pretest	Posttest
1	19	16
2	16	18
3	15	20
4	19	18
5	21	17
6	26	20
7	18	21
8	12	20
9	20	21
10	19	15
11	15	16
12	20	16
13	12	16
14	20	18
15	19	14
16	21	17
17	21	24
18	19	11
19	16	18
20	22	18
21	26	17
22	14	19
23	22	16
24	15	14
25	19	17
26	23	16
27	19	24
28	21	16
29	15	20
30	19	15
Total	563	526
Mean	18.77	17.6
SD	3.50	2.84
Computed t	1.42	
Critical t at $\alpha = 0.05$ & df = 58	1.67	
Evaluation/Decision	Not Significant/Accept H_0	

the highest mean was 5.07 indicates that they strongly agree to the statement that "the use of active material is motivational." The second highest mean was

Table 11
Evaluation of the Module by the Experimental Group

STATEMENTS	Mean/ Interpretation	Rank
1. The purposes of the active learning materials are well defined.	4.43	A 4
2. The objectives of the active learning materials are attainable.	4.47	A 2.5
3. Content presentation is clear and logical.	4.23	A 5
4. Level of difficulty is appropriate for the target audience.	4.10	A 9
5. Graphics and color are used for appropriate instructional reasons.	4.17	A 6.5
6. Use of active learning materials is motivational.	5.00	SA 1
7. The active learning materials effectively stimulate students' creativity.	4.47	A 2.5
8. Feedback on students' responses is effectively employed.	3.90	A 10
9. The learner controls the rate and sequence of presentation and drill.	4.17	A 7
10. Instruction is integrated with previous student experiences.	4.13	A 8
Grand Mean	3.89	A
Interpretation	Favorable	

Legend: 4.51 - 5.00 Strongly Agree (SA)/Very Favorable

3.51 - 4.50 Agree (A)/Favorable	1.51 - 2.50 Disagree (D)/Unfavorable
2.51 - 3.50 Uncertain (U)/Neutral	1.00 - 1.50 Strongly Disagree (SD)/Very Unfavorable

4.47 which indicates that they agree to the statements "the objectives of the active learning material are attainable" and that "the active material effectively stimulates student's creativity." Meanwhile, the lowest mean of 3.90 which is interpreted as "agree" to the statement that "feedback on student's responses is effectively employed." The second lowest mean was 4.10 which is also interpreted as "agree" on the statement that "the level of difficulty is appropriate for the target audience." The grand mean of 3.89 indicated favorable evaluation on the use of active learning material in this study insofar as the topic Matter is concerned. Hence, the students were found to be receptive to the use of active learning approach in learning chemistry concepts.

Chapter 5

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of findings, the subsequent conclusions drawn as well as the recommendations formulated.

Summary of Findings

On the basis of the analyses and interpretation of the data gathered, the following results were obtained:

1. Majority of the subjects in both groups were 16 years old. The oldest was 17 ½ years old for both groups. The average age in the experimental group was 16.47 years while in the control group was 16.42 years.
2. Majority of the subjects, both in the experimental and control groups were females inasmuch as out of 30, 20 or 66.67 percent were of this sex while only 10 or 33.33 percent were males.
3. For its scholastic performance, the experimental group posted an average grade of 85.25, where 15 or 50 percent were "above the mean" and the other half or 50 percent were "below the mean."
4. The average family income for the experimental and control group were PhP11,879.33 and PhP11,250.00, respectively. A difference of PhP629.33 was observed.

5. The average grade in the control group was 84.68, where 15 or 25 percent belonged to the "above the mean" group and the remaining 15 or 50 percent belonged to the "below the mean" group.

6. Both the experimental group and the control group have a favorable interest level in chemistry as evidenced by the grand means of 4.85 and 4.05, respectively.

7. Based on the interest inventory, the three statements on the topic "Matter" posted the highest mean of 4.83, 4.75 and 4.60 respectively.

8. The pretest means score of the experimental group was 13.07 while that of the control group was 13.40. There was a mean difference of 0.33.

9. There was no significant difference in the pretest mean scores of the two groups of respondents since the computed t of 0.42 was less than the tabular t of 2.00 which implied the acceptance of the first null hypothesis which stated that "There is no significant difference between the pretest mean scores of the control and the experimental groups."

10. Based on the pretest and posttest scores of the control group, the t -test for dependent samples yielded a computed t of 5.86 which is greater than the tabular t of 2.05. This led to the rejection of the second null hypothesis which states that "There is no significant difference between the pretest and posttest mean scores of the control group."

11. The t -test for dependent samples yielded a computed t of 7.94 which is higher than the tabular t of 2.05. Consequently, the null hypothesis

which stated that " There is no significant difference between the pretest and posttest mean scores of the experimental group" was rejected.

12. The posttest means score obtained by the experimental group was 18.77 while that of the control group was 17.60. There was a mean difference of 1.17.

13. There was no significant difference between the posttest mean scores of the two groups of respondents for the reason that when t-test for independent samples was employed, it yielded a computed t of 1.42 which is higher than the tabulated t of 2.00. This led to the acceptance of the hypothesis 4.4.

14. Based on the 30 sample pages taken from the active learning materials, the Reading Ease Score (RES) turned out to be 50.62 which meant that the readability of the developed active materials for active learning approach in Chemistry were appropriate for the first year to second year college students. Moreover, the Human Interest Score (HIS) was posted at 36.13 which classified the materials at an "interesting level."

Conclusions

On the basis of the salient findings derived from this study, the following conclusions were drawn:

1. The control and the experimental groups had more or less the same level of entry behavior on the basis of their age, sex, scholastic performance in high school average family income and pretest scores.

2. Both the control and experimental groups had a favorable interest level in Chemistry.

3. Using the Active Learning Materials in teaching Matter showed a positive response from the experimental group as evidenced by the favorable evaluation on the of active learning materials.

4. The control group showed improved performance in their pretest and posttest scores.

5. The experimental group likewise gained improved performance as evidenced by the results of the posttest scores which were significantly higher than their pretest scores.

6. The two methods of teaching, the Traditional Lecture-Discussion Method of Teaching and the Active Learning Approach are equally effective on the basis of the posttest scores of the two groups. This shows that the use of any of the two methods would have the same result on learning among freshmen college students.

Recommendations

Based on the foregoing findings and conclusions, the following recommendations were made:

1. Teachers should make use of active learning strategies in teaching college Chemistry besides the traditional lecture discussion method to break the monotonous mode in the classroom.
2. Training of teachers in the effective use of active learning materials and other innovative strategies, techniques and methods of teaching appropriate to the level of their students be conducted.
3. Administrators should provide opportunity to teachers to actively involve in the development and use of innovative teaching strategies.
4. Administrators should strengthen and sustain professional development program to teachers to update their knowledge and upgrade their strategies of teaching which enhance effective and meaningful learning of students.
5. Similar studies could be done by conducting experimental validation of active learning materials on other topics in college Chemistry.

Chapter 6

THE MODULE FOR ACTIVE LEARNING IN TEACHING CHEMISTRY 101

Dear Student,

Hello! How are you? Welcome to ALICE (Active Learning in Chemistry Education). In this course, you will learn the basic principles of chemistry specifically Matter. It will help you acquire some of the knowledge and skills which are needed in understanding many of the scientific and technological methods and issues of our times. In addition to providing you with a good background in chemistry, ALICE will help you develop some logical methods of solving problems. Unlike more traditional chemistry courses, ALICE is a program in which you will learn to be very independent. The teacher will not be the center of attention in your classroom. **YOU WILL BE!** Well, you and your fellow students will be. You will find that the teacher will not be lecturing to your class very often. Most of the time, you will be working with other students in small groups. The teacher's role will be that of a guide who will offer help and assistance to the small groups. He/she will provide you with laboratory materials you need and from time to time he/she will perform various demonstrations for your group or class.

There is no formal textbook for ALICE. Instead, you will be given special printed materials, one chapter at a time. ALICE involves "active learning." That means that you will have an active role in almost everything that happens in the classroom. As you read the materials, you will be responding to questions or solving problems. Most of the pages you read will require one or more responses from you. The correct answers to questions and problems can be

found at the end of each chapter. The laboratory activities are built right into the reading materials. The data that you collect and the conclusions that you draw will all become a part of your book. You will, however, be expected to assume a lot of responsibility. You should budget your time wisely, come to class prepared, be a contributing worker in your group, and stay on task when you are in class.

You should do your own work, even though you are encouraged to cooperate with others in your group. Discussions with your lab partner, classmates and teacher will give you more insight into the concepts being investigated. Hopefully, this type of learning will make the class more interesting to you and will actually help you learn better than if you were in a more passive and traditional role.

The grade you earn is always determined by you. Quantity will not be the decisive factor, but quality will be very important. Your grade will be your responsibility. Each lesson will be checked by your teacher who will further explain the details of how you will be evaluated. This may be the first time you will experience this form of freedom in the classroom. You can learn as much, if not more than you would in a conventional course. You have much more responsibility in your own learning. The old saying "you get as much out of something as you put into it" applies here. Learning can be accomplished by doing, seeing and listening. Learning is your responsibility. It always has been but now your responsibility has increased.

From time to time, you will be working in a laboratory. Some of the equipment you will be using may be expensive. Careful handling of this equipment will be showed by your teacher. Always practice safety in the lab. Safety in the laboratory is a primary concern of everyone. Always and immediately report any accident, injury or equipment breakage to your teacher. Always use safety glasses and an apron when working in the laboratory. You can be sure no childishness will be tolerated in the lab. Write careful responses. Your written work should be complete with proper grammar, punctuation and correct spelling. In addition, please be neat. No response has any value if it can't be read.

Enjoy your lessons and Happy Learning.



Your friend,

Alice

WHAT IS MATTER ?

During the past two centuries, scientists have made great progress in understanding what we and the world about us are made of. First, came the realization that matter consists of basic substances, or elements, with well defined physical and chemical properties. These elements range from hydrogen, the lightest, through to uranium and beyond.

Matter is defined as anything that has mass and occupies space. Matter is sometimes called *koinomatter* (Gr. *koinos*=common) to distinguish it from antimatter, or matter composed of antiparticles.

Early Theories of Matter

In ancient times various theories were suggested about the nature of matter. *Empedocles* held that all matter is made up of four “elements”—earth, air, fire, and water. *Leucippus* and his pupil *Democritus* proposed an atomic basis of matter, believing that all matter is built up from tiny particles differing in size and shape. *Anaxagoras*, however, rejected any theory in which matter is viewed as composed of smaller constituents, whether atoms or elements, and held instead that matter is continuous throughout, being entirely of a single substance.

Modern Theory of Matter

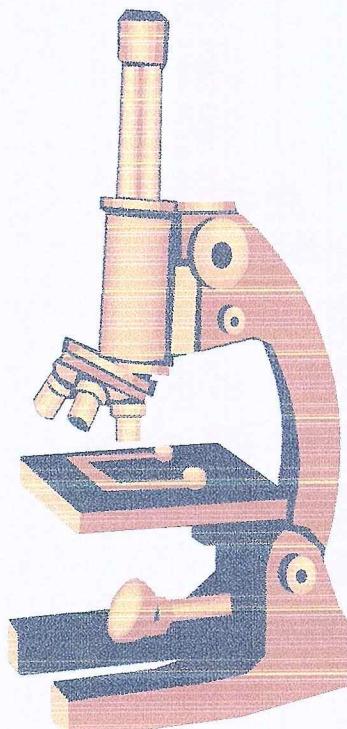
The modern theory of matter dates from the work of *John Dalton* at the beginning of the 19th century. The atom is considered the basic unit of any element, and atoms may combine chemically to form molecules, the molecule being the smallest unit of any substance that possesses the properties of that substance.

MODULE 1

OBSERVATION OF MATTER

Objectives:

At the end of this module you are expected to:



- Show recognition of the procedures of the scientific method by being able to name them when they are illustrated by certain activities.
- Discuss the role of each procedure of the process of inquiry in the growth of science.
- Distinguish between a law and a theory.

Science is a body of knowledge as a process of learning about things. It involves a search of facts (making observations), finding regularities about them (generalizations) and finding explanations for them (wondering why).

ACTIVITY 1.1

“Bubbles”

In this activity you will be able to have a depth understanding of the scientific method.

Introduction

What makes an effective bubble-blowing mixture? Does adding chemicals could affect its bubble mixture?

Make your own hypothesis.

In this investigation we will develop a hypothesis based on physical data collected from our classmates. We will then test this hypothesis by conducting the experiment “Bubbles”.

Materials:

3 plastic cups	½ teaspoon sugar
3 teaspoon liquid dish detergent	½ teaspoon salt
Measuring cup	drinking straw
150 mL water	

Procedure:

1. Label three cups 1, 2, 3. Measure 1 teaspoon liquid dish detergent into each cup. Use the measuring cup to add 50 mL of water to each cup, then swirl the cups to make a clear mixture.
2. Add $\frac{1}{2}$ teaspoon table sugar to cup 2 and add $\frac{1}{2}$ table salt to cup 3. Swirl each cup for 1 minute.
3. Dip the drinking straw into cup 1, withdraw it and blow gently into the straw to make the largest bubble you can. Practice making bubbles until you feel you have reasonable control over your bubble production.
4. Repeat step 3 with the mixtures in cups 2 and 3.

DQ2. Restate your hypothesis:

DQ3. Describe the bubbles made in

Cup 1 _____

Cup 2 _____

Cup 3 _____

DQ4. Which cup made the biggest bubble? _____.

DQ5. Was your hypothesis correct? _____.

DQ9. If not, explain what was different.

Science begins with observation, casual or planned, as in experiments where conditions are controlled. Observation involves measurement with or with the use of instruments, of some property of an isolated portion of the universe called a "system". These observations are the "data" and their accuracy is limited by the measuring device used.

The development of science involves the interaction of mind and facts. **Observation**- things actually witnessed or measured- are different from **interpretations**- the meaning given to observations. Thus, an increase in the reading of the level of mercury in the thermometer is an observation but the statement that the temperature and the energy of the system has increased, is an interpretation.

Observation versus Interpretation

Observation: a report from your senses or a measurement. It is not an explanation of any kind.

Examples: a) Of the thousand leaves on the tree, 452 do not have any red spots on them.

b) The candle has a slight odor and no taste.

DQ10 c) _____

DQ11 d) _____

Observation can be qualitative or quantitative observations.

❖ *Qualitative Observation:* does not involve measurements

Examples

a) The leaves are green.

b) The candle has a slight odor and no taste.

DQ12 c) _____

DQ13 d) _____

❖ *Quantitative measurement:* involves measurements made with one estimated figure.

Examples

a) There were 567 ± 1 leaves on the tree.

b) The mass of each leaf was 0.95 ± 0.02

DQ14 c) _____

DQ15 d) _____

Interpretation or Inference: an attempt to explain an observation.

Examples 1.

- a) Chemicals known as anthocyanins are being produced in 548 of the trees' 100 leaves.
- b) The candle's odor is due to paraffin.

DQ16 c) _____

DQ17 d) _____

The ***scientific method*** is process by which scientists, collectively and over time, endeavor to construct an accurate (that is, reliable, consistent and non-arbitrary) representation of the world.

Recognizing that personal and cultural beliefs influence both our perceptions and our interpretations of natural phenomena, we aim through the use of standard procedures and criteria to minimize those influences when developing a theory. As a famous scientists once said, "Smart people (like smart lawyers) can come out with very good explanations for mistaken points of view."

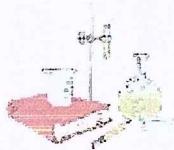
In summary, the scientific method attempts to minimize the influence of bias or prejudice in the experimenter when testing a hypothesis or theory.

There is always the possibility that a new observation or a new experiment will conflict with a long-standing theory. If the experimenters bear out the hypothesis it may come to be regarded as a *theory or law of nature*.

⊕ ENRICHING ACTIVITIES

Underline the inferences/interpretations in the following text.

The candle's diameter was 2.0 cm. When unlit it consisted of a translucent white solid. Both its wick and wax burned after it was lit, and in 20.3 minutes, its mass decreased from 10.23 g to 8.04 g. The escape of carbon dioxide accounted for this loss in mass. My partner, who put out the candle by cutting off its oxygen supply, noticed black particles floating in a pool around the wick.

**Self-test**

Name: _____ Score: _____

Direction: Choose the best answer.

1. A doctor did several medical test on a patient like X-ray, blood test, urine test and stool test. Which of the following steps of a scientific method was applied by the doctor to his patient?
 - a. identifying the problem
 - b. formulating hypothesis
 - c. testing hypothesis
 - d. giving generalization
2. A hypothesis is
 - a. a description of a pattern or relationship in experimental data
 - b. obeyed under any circumstances
 - c. a theory that has been proved
 - d. a tentative explanation for a natural phenomenon
3. A number of people become ill after eating dinner in a restaurant.

Which of the following statements is a hypothesis?

- a. People got sick whether the oysters were raw or cooked.
- b. Symptoms include nausea or dizziness

c. Bacteria in the oysters may have caused the illness.

d. Everyone who eat the oyster got sick.

4. The statement, "Osmium has a density of 22.59 g/mL, which makes it a densest element known" is an example of

- an experimental observation
- a law
- a theory
- a hypothesis

5. The statement "a chemical reaction never creates products that weigh more or less than the reactants is based on three centuries of experimental observation. The statement is an example of:

- a theory
- a law
- a hypothesis
- a datum

6. A natural law is

- a description of a pattern or relationship in experimental data
- obeyed under any circumstances
- a theory that has been proved
- a tentative explanation for a natural phenomenon

7. A scientific theory

- is a natural law.

- b. is an initial explanation of observations.
- c. can always be proven to be correct.
- d. is a hypothesis that repeatedly withstands the test of experiments and has overwhelming supportive evidence.

8. The ability to use existing facts to derive new information is known as

- a. sensory experience
- b. expert opinion
- c. logic
- d. scientific method

9. Which of the following is most correct?

- a. You can accept or reject a hypothesis, but never prove it to be true.
- b. You can prove a hypothesis to be true.
- c. You can prove a hypothesis to be false.
- d. Accepting or rejecting hypothesis is the same as proving whether or not the hypothesis is true.

10. The first step of the scientific method involves:

- a. forming hypothesis
- b. making observations
- c. performing an experiment
- d. predicting the result of an experiment

Answers to Developmental Questions (Module 1)

Answers to DQ1 to DQ9 would be based on the results of the activity "I'm all thumbs up" conducted by the students while DQ10 to DQ17 would depend on the responses of the students.

Answers to Self-test

1.	a	6.	b
2.	d	7.	d
3.	c	8.	d
4.	c	9.	a
5.	c	10.	b

FEEDBACK to Answers

You are **Outstanding!** If your score is 10.

Great! If you score 9 or 8.

Just fine! If you score 7 or 6.

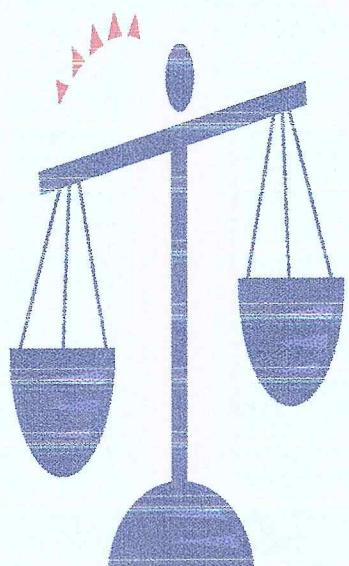
If you score 5 and below, **Study more.**

MODULE 2

MEASUREMENT OF MATTER

Objectives:

At the end of this module, you are expected to:



- Identify the proper names of some common pieces of laboratory equipment.
- Read laboratory measuring instruments properly, recognizing the amount of uncertainty in the measurement.
- Differentiate qualitative observations from quantitative observations.

Some of the most important skills you will be developing in this course are those of observing and measuring. Observation and measurement allow you to collect data and then interpret that data in order to figure out some of the "whys" and "hows" around you. Experimentation followed by observation and measurement will allow you to answer many of these questions. Some such questions may include the following: "Why do we put baking soda in most baked goods?", "What makes such diamonds such hard substances?", "Why are some things in our environment so harmful to plant and animal tissue?".

Measurement of Length

Distances are commonly measured with a meterstick or a ruler divided into inches or centimeters. The limit of accuracy of a meterstick is indicated by how "close" you can read the length on a meterstick scale (that is, how well you can estimate the fractions of degrees between the marks)

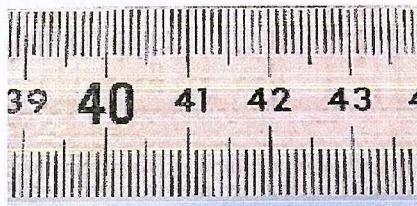


Figure 1. This meter stick is calibrated in centimeter with the least count of mm.



Figure 2. An example of a meterstick reading. The object length is measured to be 41.64 cm.

A measurement reading usually has one more significant figure than the least count reading of the scale. The least count of our laboratory meter sticks is 0.1cm and therefore a reading can be made to 0.01cm. Figure 2 above shows a meter stick being used to measure the length of a plastic strip. The meter stick is calibrated in centimeters, so we know that the strip is between 41 and 42 cm. The least count of this meter stick is one millimeter, so we know with absolute certainty that the object is between 41.6 cm and 41.7 cm. We then estimate the object's length to the fractional part (doubtful figure) of the least count subdivision. In Figure 2, it we may estimate that the strip is closer to 41.6 cm than it is to 41.7 cm and report the length to be 41.64 cm or 0.4164 m.

See if you can correctly read the measurements in the photos below:

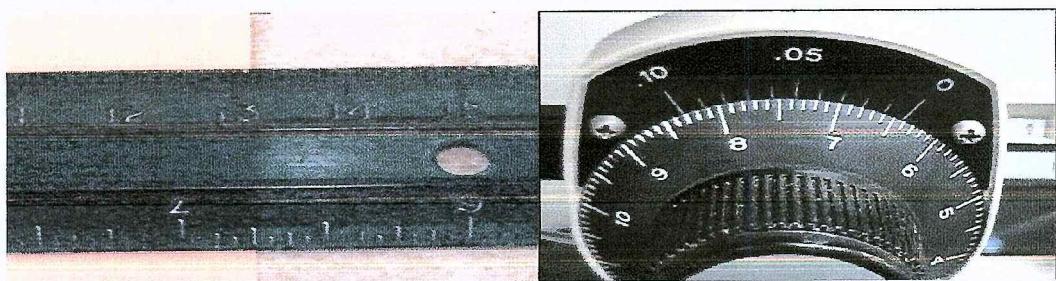


Figure 3. A ruler and a balance scale.

DQ1. _____ cm

DQ2. _____ g

ACTIVITY 2.1

Measuring Length

Estimate the length and width of this page in centimeters without using a measuring instrument.

DQ3. What is your estimate of its length? _____ cm.

DQ4. What is your estimate of its width? _____ cm.

Get a ruler or meterstick and measure the length and width of this page.

DQ5. What is the length (in cm) between the closest marks on your measuring device? _____ cm.

DQ6. What decimal place is your measuring device accurate to?
_____ cm.

DQ7. What is the length of this page? _____ cm

DQ8. What is the width of this page? _____ cm.

DQ9. How much uncertainty (in cm) is there in your measurements?
_____ cm. (The answers to the above will depend on the type of ruler or meterstick you are using.)

Measurement of Temperature



This time, you will be trying to your skills at estimating temperature and learning how to read a thermometer properly. This will not be as easy as it may seem In science, temperature is usually measured and recorded in degrees Celsius, °C. You are probably familiar with the fahrenheit scale. The Fahrenheit scale is most probably used in daily weather reports. You should be able to make a ballpark estimate in °C knowing that room temperature, usually about 72°F is equal to 25°C.

What to do: It's easy to read a thermometer once you know how to do it. Hold the thermometer up in front of you. Can you see the red line in the middle? That red line is a liquid. It measures temperature. You may need to tilt your Metal Thermometer slightly to one side or the other to get a good view of the red line. As temperature rises (gets warmer) the liquid in your thermometer expands and rises. What do you think the liquid does when temperature falls (gets colder)? Where is the top of the red line on your thermometer right now? You can read the temperature number in degrees Fahrenheit (°F) or degrees Celsius (°C).

DQ10. What is the temperature, in °C, of the room you're in right now? _____

ACTIVITY 2.2

Measuring Temperature

Fill a small beaker about halfway with water. Now, obtain a thermometer with a range of about 110 to 120°C (Use the same procedure used in determining the uncertainty of the meterstick to determine the uncertainty of the thermometer.

DQ11. How many degrees are represented between the closest marks on the temperature scale? _____ °C.

DQ12. To what column can the thermometer be estimated?
_____ °C.

DQ13. What is the temperature of water? _____ °C.

DQ14. What is the uncertainty in the temperature value you obtained? _____ °C.

Return the thermometer to the lab shelf and have a beaker for the next activity.

Measuring Volumes of a Liquid

The volume of a liquid is normally measured in liters (L) or in milliliters (mL) in the chemistry laboratory. If you are not familiar with the quantity of a liquid that makes a liter or a milliliter, you may have some trouble estimating volumes. But don't worry, because by the end of this course, you will probably be an expert. Almost every lab activity you will be doing throughout this course involves measuring volumes.

ACTIVITY 2.3

Measuring Volume

Obtain a 50mL graduated cylinder. Look at the cylinder and then at the water in the beaker used in the previous section.

DQ15. What is your estimate in mL in the volume of water in the beaker? ___mL.

Before measuring the actual volume of the liquid, you must learn how to read a graduated cylinder properly. Many liquids in a graduated cylinder have cohesive properties. This means the particles of a liquid have the tendency to stick to each other., there is also adhesive property of most liquids to glass, meaning unlike particles (liquid and glass) stick to each other. These two properties (cohesion and adhesion) combine to cause a liquid to "climb" the walls of a graduated cylinder and form a bend or dip on the surface of a liquid. This dip is called the *meniscus*. When measuring the volume of a liquid, you should place your eye even with the bottom of the meniscus.

Study Figure 5 carefully.

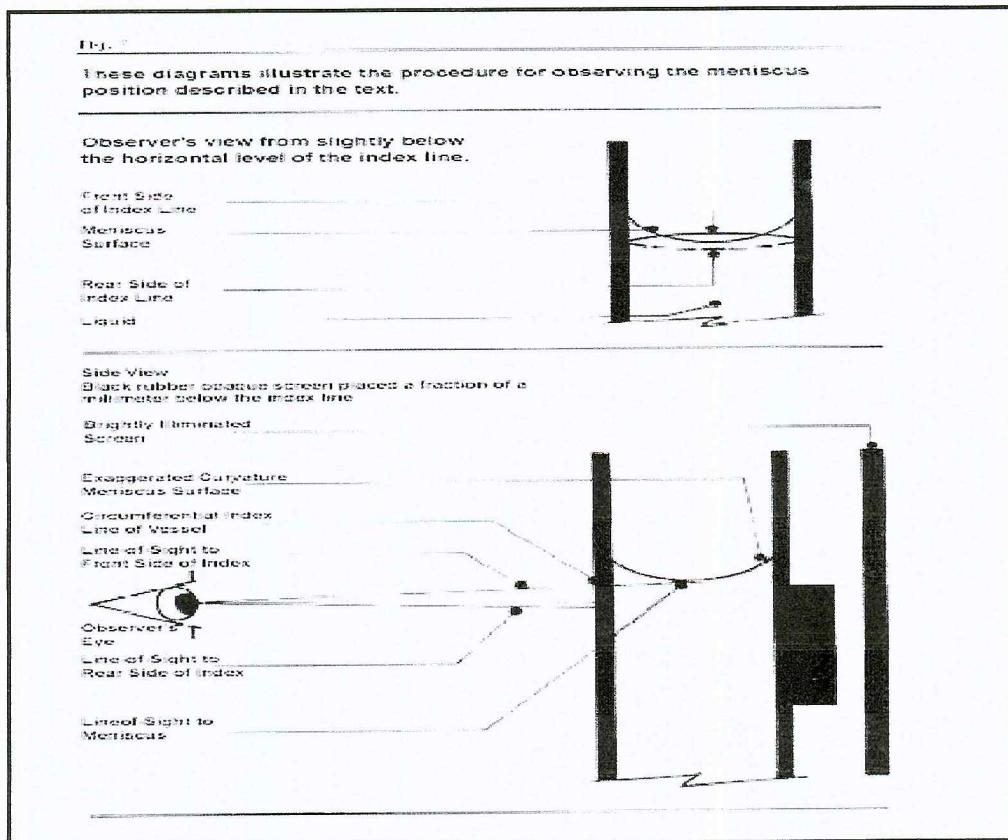


Figure 5. Reading a Meniscus

Measuring Volume of an Irregular Solid

The illustration below shows two ways to measure the volume of an irregular solid. In Figure A, small object A is placed in a known volume of water in a graduated cylinder. In Figure B, large object B is placed in an overflow can filled with water. The object forces water out of the spout of the overflow can into a beaker. The volume of water in the beaker is accurately determined by pouring the water into a graduated cylinder.

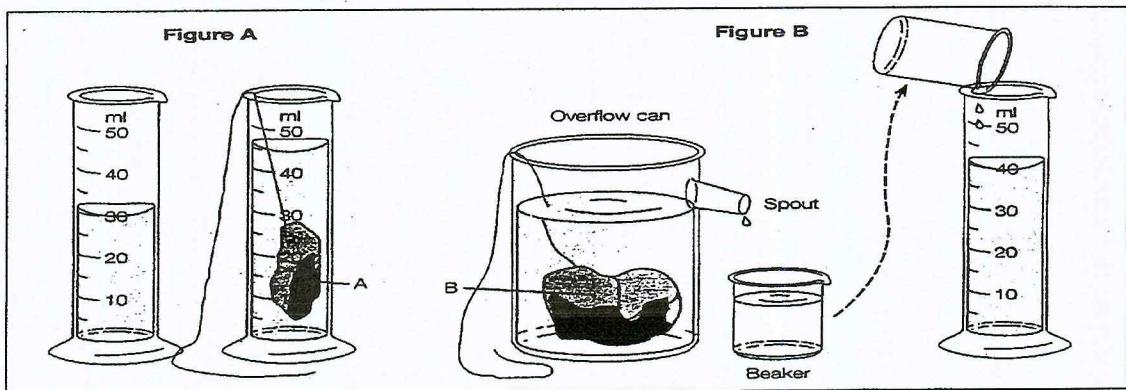


Figure 6. Measuring Volume of an Irregular Solid

DQ16. In Figure A, what is the volume of the water before small object A is placed in the graduated cylinder? _____.

DQ17. What is the volume of small object A? _____.

DQ18. In Figure A, what is the volume of the water after small object A is placed in the graduated cylinder? _____.

DQ19. In Figure B, what is the volume of large object B? _____.

Measuring Weights

There are various types of laboratory balances. The triple beam balance you use may look somewhat different from the one in the Figure below, however all beam balances have some common features.

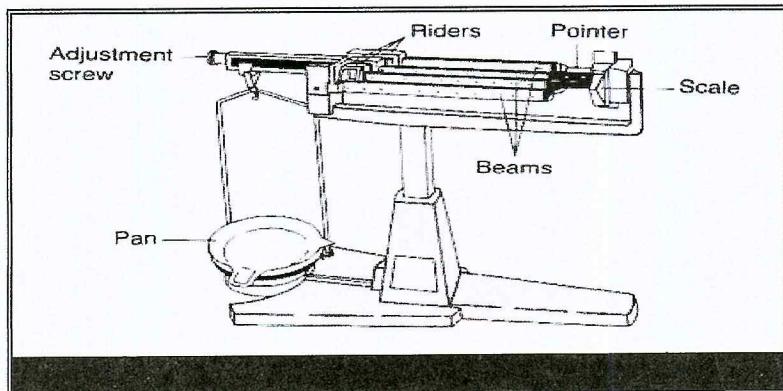


Figure 7. A Triple Beam Balance.

Carrying the Balance

1. Be sure all riders are back to the zero point.
2. Place one hand under the balance and the other hand on the support (arm) to carry the balance.

Using the Balance

1. **Zero the balance** before you determine the mass of any substance.
 - a) Slide all of the riders back to the zero point.
 - b) Check to see that the pointer swings freely along the scale
 - c) Use the adjustment screw to obtain an equal swing of the beams, if necessary. You do not have to wait for the pointer to stop at the zero point. The beam should swing an equal distance above and below the zero point. You must repeat this procedure to "zero" the balance every time you use it.
2. **Never put a hot object directly on the balance pan.** Any dry chemical that is to be massed should be placed on paper or in a container. *Never pour chemicals directly on the balance pan.* Remember to mass the paper or container before adding the substance.

ACTIVITY 2.4

Use of Balance

Obtain a piece of weighing paper and put it on the balance pan. Note the mass of the paper. We are now going to measure out about 5 grams of rock salt onto the weighing paper. Obtain a bottle of rock salt and use a spoon or scapula to add about 5 grams of salt to the paper.

DQ20. What is the mass of the paper? _____ g

DQ21. What is the mass of the paper with salt? _____ g

DQ22. What is the mass of the salt? _____ g

Use of the Laboratory Burner

As you work in the chemistry laboratory, there are several procedures or techniques that are commonly used. You will now be given an opportunity to practice some of these basic procedures. One piece of equipment you will frequently be using is a burner.

Figure 8 illustrates the anatomy of a typical burner. Attach your burner to a gas outlet at your lab station using a two or three foot length of rubber tubing which is in good condition. Be sure that the connections are tight.

1. Obtain a flame igniter or lighter. Be very careful if you have long hair. Hair will burn very quickly if it gets too close to the flame. It is a good idea to tie long hair back.
2. Turn the gas on so that the valve is completely open- this means that the handle of the valve should be located directly overtop of the valve itself. The flow of a gas should not be controlled from the main valve, but rather it should be controlled by the valve of the burner itself.
3. Step back from the burner and light the gas. If you cannot light it, do not allow gas to continue to flow. Turn it off and ask the teacher for assistance.

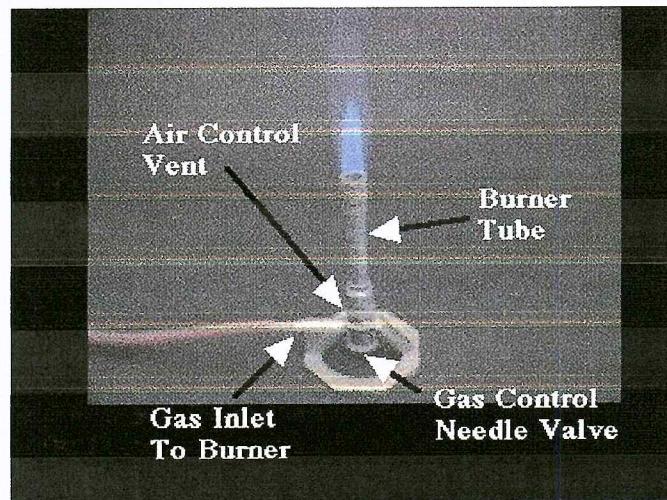


Figure 8. Anatomy of a Laboratory Burner

The burner flame should be blue in color and about 1 to 2 inches in height. If the flame is yellow, more air is needed (turn the barrel counterclockwise). If the flame keeps blowing out, less air is needed (turn the barrel clockwise). If the flame is too long or short, adjust the gas flow by turning the valve at the base. Ask your teacher to help you if you are uneasy with the process. The hottest part of the flame is at the inverted light blue cone within the flame. The tip of this cone should touch the bottom of the object being heated for maximum efficiency. Before moving on, be sure you can light and adjust your laboratory burner properly and with confidence.

ACTIVITY 2.5

Manipulation of Glass Tubing

Occasionally, you will be doing laboratory activities that require the manipulation of glass tubing. At this point, your teacher will demonstrate to you the proper way to cut, bend, and seal glass tubing using a large high-temperature burner or a regular burner.

The teacher will demonstrate these techniques in front of the entire class. Caution! Hot glass cools very slowly so allow it to cool completely before touching it. Water may cause hot glass to shatter- even Pyrex. After the teacher demonstration, you will be given specific tasks to perform with the glass tubing. Each student will be required to (1) File and break two pieces of glass tubing to a proper length (15 to 20 cm). Use those pieces to (2) Make a 90-degree glass bend fire polished at each end and (3) make a stirring rod (15 to 20 cm long) sealed at both ends.

Check with your teacher after you have completed the tasks.

Procedures:**Cut Glass Tubing:**

1. Using one edge of a triangle file, score the glass by pushing the file across the tubing. Use just enough pressure on the file to score the glass. Do not "saw" with the file.
2. Turn the mark AWAY from you placing your thumbs so the mark can be seen between them.
3. With one quick motion, push your thumbs "through" the glass tubing. DO NOT pull the tubing toward you with your fingers.
4. A perfect cut will have no jagged edges, but the flat edge of the tubing is SHARP.

Bend Glass Tubing:

1. Use one half of the tubing you have just cut.
2. Place a flame spreader on your laboratory burner. This allows a wider area of the glass tubing to be heated at one time.
3. Holding the tubing at each end with your fingers, roll the tubing in the hottest part of the flame.
4. When the tubing begins to "feel" soft, remove it from the flame and quickly bend the tubing to 90°.

5. Lay the tubing on the lab table away from your work area.

The tubing is very HOT and cools to the touch very SLOWLY.

Fire-polish Glass Tubing:

1. Using the other piece of the tubing you cut, hold it at 45° with the cut edge in the hottest part of the flame. Do not use a flame spreader when fire-polishing.
2. Roll the tubing back and forth between your fingers until the sharp edge just begins to round. If you do this too long, the hole in the tubing will begin to close. DO NOT let this happen.
3. Lay the tubing on the lab table away from your work area.

The tubing is very HOT and cools to the touch very SLOWLY.

Physical properties of matter can be described qualitatively and quantitatively.

QUALITATIVE OBSERVATIONS

Qualitative data are recorded as descriptions using our senses. The five senses are categorized as taste, smell, hearing, touch and sight (See Table 1).

Table 1

Examples of Qualitative Observations of Matter Obtained Using Our Five Senses

Senses	Qualitative Observations of Matter
Taste	Bitter, sweet, salty or sour
Smell	Foul or pleasant odor
Hearing	Soft, loud, high, low, discord or harmonic sound when struck
Touch	Smooth, hard, soft, cold, warm, hot, elasticity
Sight (Enhanced with use of microscope or telescope)	Color, shape, size

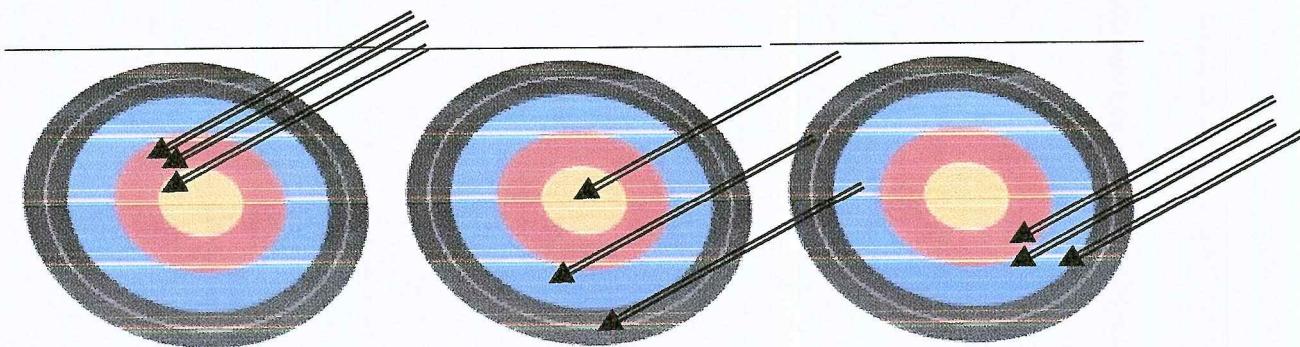
QUANTITATIVE OBSERVATIONS

In order for valid conclusions to be drawn from quantitative measurements in science, it is essential that those measurements be both repeatable and reliable. The reliability of a measurement refers to how close a value is to the true or accepted value and is called accuracy. Careful selection and calibration of laboratory equipment can go a long way toward ensuring

accurate measurements. The repeatability of a measurement is called precision, and is usually talked about in two ways – how close a series of measurements are to one another, and the “fineness” of a particular measurement, which will be discussed momentarily.

The figure below showing the archery targets is a good way to visualize the difference between accuracy and precision. In the first scenario, the arrows all strike the target near one another, but they are all far from the bull’s-eye. This would represent an experiment whose data are precise but not accurate since the result is repeatable but not reliable. In the second scenario, none of the arrows hit the center, meaning the results were neither accurate nor precise. On the final target, the results are both accurate and precise as all arrows strike near the bull’s-eye.

Figure 10. Archery targets illustrating accuracy and precision.



Suppose we set up an experiment in which three students measure the temperature of boiling water using different thermometers. Each student takes a measurement, waits one minute, takes another measurement, and so on until each thermometer has recorded four temperature values. The results shown in Table 2:

TABLE 2	Student One	Student Two	Student Three
Trial 1	99.4°C	97.3°C	100.1°C
Trial 2	102.3°C	97.4°C	100.0°C
Trial 3	101.7°C	97.4°C	99.9°C
Trial 4	101.3°C	97.3°C	100.0°C

From this information we can determine which experimental data is best both repeatable and reliable. The true boiling point of water is 100.0°C, so accurate data would give values at or very near that number. Precise measurements are repeatable, as indicated by the results from students Two and Three. So let us analyze the data shown here: The first student's data is neither accurate nor precise. This could be due to errors made by the experimenter, or perhaps the thermometer is faulty in some way. The second student's data is precise, but is not accurate. This is likely due to an incorrectly calibrated

thermometer that gives consistently low temperature readings. The third student recorded temperatures close to the true value (accurate) and reported similar temperatures repeatedly (precise).

As mentioned earlier, the second use of the term precision refers to the "fineness" of a measurement. To illustrate this concept, consider a beaker, a graduated cylinder, and a buret each filled with the same quantity of water:

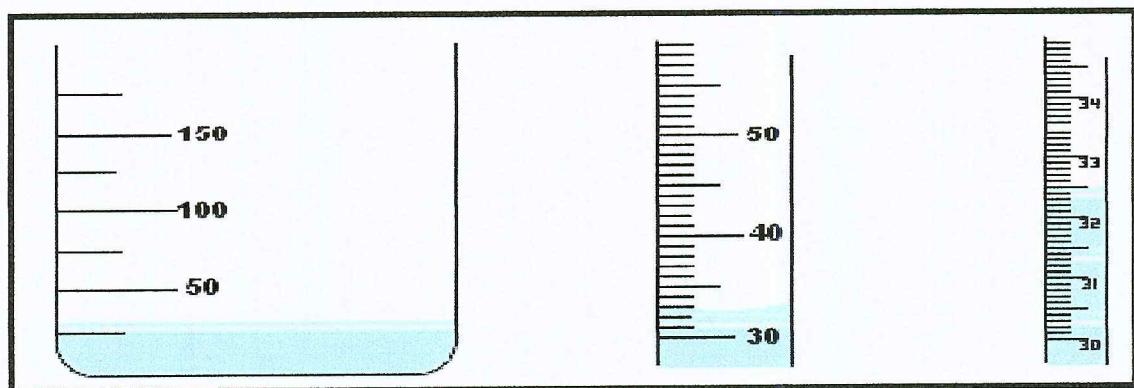


Figure 11. Estimating Measurement of a Volume

As we look at the markings on the beaker, we see that the smallest increments are 25 mL. When reading a measurement, we can always make a "guess" as to the very last digit in the number. We can estimate one decimal place smaller than the smallest increment on the instrument. In this case, the smallest increment is 25, so the best approximation we can make is to the tens place. Perhaps a good approximation for this volume would be 30 mL.

It is impossible to know the volume in the beaker more *precisely* than this. For this reason, beakers are rarely used for measuring volume. In the graduated cylinder, the smallest increment between markings is one milliliter, so we can approximate one decimal place smaller than one, the one-tenths place. As a general rule, if the markings are too close together to approximate ten smaller markings, then estimate by halves. Since the meniscus of the water in the cylinder rests between 32 and 33 mL, then we could report this volume as 32.5 mL.

Classify each statement as either qualitative or quantitative.

DQ23. The basketball is brown. _____

DQ24. The diameter of the ball is 31 cm. _____

DQ25. The air pressure in the basketball is 12 pounds per square inch.

DQ26. The surface of the basketball has indented seams. _____

SIGNIFICANT FIGURES

Since the instrument itself determines the degree of precision, it follows that all measurements are understood to contain a certain amount of error, either human or instrumental. It is impossible to measure exactly five and one-half grams of table salt, for example. We may be able to measure 5.5 grams, 5.50 grams, or even 5.500 grams, but none of these measurements represents *exactly* five and one-half grams. The first is reliable to only the tenths place – somewhere between 5.4 and 5.6 grams. The last is much more precise – between 5.499 and 5.501 grams – but it is still not exact. The final reported digit of any measurement is *uncertain*. It is an approximation, just like in the previous section where we estimated between graduations on an instrument. A measurement contains two kinds of *significant figures*, those that are known and one final approximated digit. The more significant figures a number has, the more precise the measurement is.

Determining the Number of Significant Figures

This is actually a fairly simple process, as long as the rules for significant figures are understood. These rules are:

- 1) **All nonzero digits are considered significant**
ex: The measurement 546 grams has three sig-figs
- 2) **Zeros between significant figures are considered significant**

ex: The measurement 3.502 seconds has four sig-figs

3) **Trailing zeros after a decimal are considered significant**

ex: The measurement 22.50 pounds has four sig-figs

4) **Zeros that serve as placeholders are not significant**

ex: The measurements 100 mL and 0.05 ft each have only one sig-fig

0.02030 m (4 sig figs)

200 m (1 sig fig)

200.0 m (4 sig figs)

200. (3 sig figs)

Now try these, determine the number of significant figures.

DQ27. 1421798.076 _____

DQ33. 40.007 _____

DQ28. 0.000993385 _____

DQ34. 143 g _____

DQ29. 0.00099985 _____

DQ35. 0.07 _____

There are some numbers, however, that are exact, having an infinite number of significant figures. These numbers are counting numbers (exactly 12 eggs in one dozen), defined constants (exactly 2.54 centimeters in one inch), and metric definitions (one kilometer is exactly 1000 meters).

Calculations Involving Measurements

Significant figures indicate the degree of precision in any measurement, and when those measurements are used in calculations, the precision remains with it. This means a set of data can only be as precise as its least precise value:

Addition and subtraction:

- The answer must not contain any significant figures beyond the place value common to all numbers

Example: 2.015

$$\begin{array}{r}
 + \quad 4.8 \\
 \hline
 6.8 \quad (\text{not } 6.815)
 \end{array}$$

Multiplication/Division

- The answer must not contain more significant figures than the least number of significant figures in the measurements.

Example: 4.01

$$\begin{array}{r}
 \times \quad 3.1 \\
 \hline
 12 \quad (\text{not } 12.431)
 \end{array}$$

DQ38. $14.085 + 9.4 = \underline{\hspace{2cm}}$

DQ39. $11 \text{ m} \times 12 \text{ m} = \underline{\hspace{2cm}}$

LE SYSTÈME INTERNATIONAL

In any quantitative measurement, the number is only part of the value. All measurements have both a quantity and a unit, each as important as the other. If you ask someone how much pizza they ate last night and they respond "6," what does that mean? Six pizzas? Slices? Pounds? Kilograms? Ounces? Cups? Dozen?

The numerical value is essentially useless without knowing the unit that is associated with it. And just as important is to know the general scale of each unit. Is six ounces of pizza a reasonable amount? Which is larger – six pounds of pizza or six kilograms of pizza? The problem lies in the fact that there are dozens of systems of measurement used around the world, and the basis for those measurements have changed throughout history.

In 1960, the 11th General Conference laid down the standards for a new system of units that would become the Système International d'Unités, commonly referred to as SI. The SI established six base units (the seventh was added in 1971) from which all other measurements could be derived, as well as prefixes and rules for writing abbreviations. The units pertinent to chemistry are listed in Table 2.3, as well as the standard on which they are based. All seven base units are based on a universal physical constant except the kilogram, which is also the only base unit with a prefix.

LENGTH	
1 mile = 1.61 kilometers	1 kilometer = 0.621 miles
1 yard = 0.914 meters	1 meter = 1.09 yards
1 foot = 30.5 centimeters	1 centimeter = 0.394 inches
	1 inch = 2.54 centimeters*
MASS	
1 carat = 200 milligrams*	1 gram = 0.0352 ounces
1 ounce = 28.4 grams	1 kilogram = 2.20 pounds
	1 pound = 0.454 kilograms
VOLUME	
1 Tablespoon = 14.8 milliliters	1 milliliter = 1 cubic centimeter*
1 cup = 237 milliliters	1 liter = 1 cubic decimeter*
1 quart = 0.946 liters	1 liter = 0.264 gallons
	1 gallon = 3.79 liters
TEMPERATURE	
$0^{\circ}\text{C} = 32^{\circ}\text{F} = 273.15 \text{ K}^*$	
$100^{\circ}\text{C} = 212^{\circ}\text{F} = 373.15 \text{ K}^*$	
$^{\circ}\text{C} = (9/5)(^{\circ}\text{F} - 32)$	
$\text{K} = ^{\circ}\text{C} + 273.15$	

You may have noticed that some of the units in the table to the right include prefixes such as milli-, centi-, and deci-. These occur because there are

many occasions on which using the standard base unit in the SI is impractical due to the magnitude of the measurement. For example, you wouldn't want to measure the mass of an electron in kilograms (approximately 0.000000 000 000 000 000 000 000 0091 kg) or the distance from the sun to Jupiter in meters (778 330 000 000 000 000 m). The numbers would be either very large or very small and extremely cumbersome. There are two ways of solving this problem – using scientific notation, or altering the magnitude of the unit by changing the prefix.

Scientific Notation

Scientific notation simply expresses any value as a number between 1 and 10 multiplied by a factor of ten. For example, 1 000 000 would be expressed as 1×10^6 and 0.000 000 01 would be 1×10^{-7} . When expressing a number in scientific notation, the number of significant figures should be the same as in the original number. To illustrate this, the mass of an electron from above would be 9.1×10^{-31} kg and the distance to Jupiter would be 7.7833×10^{11} m.

Example:

The mass of 1 molecule of water is 0.000 000 000 000 000 029 916 grams

This may also be expressed as 2.9916×10^{-23}

Notice the decimal place has been moved 23 places to the right to obtain a number between 1 and 10. Moving the decimal to the right to express a very small number results in a negative exponent; moving the decimal to the left to express a very large number results in a positive exponent.

All significant figures are shown in scientific notation.

Express the following numbers in scientific notation and report their number of significant figures.

DQ40. 602,217,000,000,000,000,000,000 _____

DQ41. 0.000 000 000 000 000 420 _____

Round each measurement to the number of significant figures shown in parenthesis. Write the answers in scientific notation.

DQ42. 314.721 meters (4) _____

DQ43. 0.001 775 meters (2) _____

DQ44. 64.32×10^{-1} meters (1) _____

DQ45. 8792 meters (2) _____

Round each measurement to three significant figures. Write your answer in scientific notation.

DQ46. 87.073 m _____

DQ47. 4.3621×10^8 m _____

DQ48. 0.01552 m _____

DQ49. 9009 m _____

DQ50. 1.7777×10^{-3} m _____

DQ51. 629.55 m _____

Prefixes

Prefixes				
Tera-	T	Trillion	10^{12}	
Giga-	G	Billion	10^9	
mega-	M	Million	10^6	
kilo-	K	Thousand	10^3	
hecto-	H	Hundred	10^2	
Deca-	Da	Ten	10^1	
Deci-	D	Tenth	10^{-1}	
centi-	C	Hundredth	10^{-2}	
Milli-	M	Thousandth	10^{-3}	
micro-	μ	Millionth	10^{-6}	
nano-	N	Billionth	10^{-9}	
Pico-	P	Trillionth	10^{-12}	

The alternative to scientific notation for measurements is to use a prefix that serves the same purpose as the power of ten. For example, kilo- means 1000 (10^3), so 8.3 kilometers is simply 8.3×10^3 m, or 8300 meters. Additional prefixes are in Table 2.5. Using these prefixes, we could express the distance from the sun to Jupiter in, say, terameters (Tm) or gigameters (Gm). Unfortunately we don't

have a prefix small enough to represent the mass of an electron so we'll have to stick to scientific notation for that one.

DIMENSIONAL ANALYSIS

It is useful to have a quick and straightforward way to express a measurement with different units without having to measure again and again. Once a measurement has been taken, it can be converted to any system using a process called dimensional analysis. Any unit can be converted to any other unit as long as there exists a known relationship between the two. Let's assume we measured the length of a sheet of paper and found it to be 8.5 inches. What is this value in centimeters? We can solve this or any other computational problem using dimensional analysis.

We know that a relationship exists between the unit we have (inches) and the unit we want (centimeters) – one inch is equal to exactly 2.54 centimeters.

If we create a ratio, the value is fundamentally equal to one since both 1 in and 2.54 cm are the same quantity.

$$\frac{2.54 \text{ cm}}{1 \text{ in}} = 1 \quad \frac{1 \text{ in}}{2.54 \text{ cm}} = 1$$

Multiplying the original measurement by one of these ratios will not change the physical quantity, only the units with which it is being expressed. So

how do we know which ratio to use? Just like in algebraic equations, when a value or unit appears in both the numerator and the denominator, it can be cancelled out. Since we want to remove the unit "inches" and replace it with "centimeters," we will choose the second ratio so that inches cancels out. Then we simply multiply and round the answer to the correct number of significant figures.

$$8.5 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 21.59 \text{ cm} = 22 \text{ cm}$$

This method can be used with practically every problem in chemistry. It provides a standard approach to problem solving and is also easy to double check for accuracy. As long as the conversion factors are correct and the units cancel out, we can be certain of the outcome.

Example 1: Express the quantity 3.2 kg in milligrams.

We don't immediately know the relationship between kg and mg, but we do know that 1 kg is 1000 g and 1 g is 1000 mg. So we will first convert from kg to g, then from g to mg:

$$3.2 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1000 \text{ mg}}{1 \text{ g}} = 3,200,000 \text{ mg} = 3.2 \times 10^6 \text{ mg}$$

DQ34. Express 55 mg to kilogram _____ kg

Example 2: A ream of paper weighs 5.0 kg and costs P102.50. What is the price of one gram of paper?

If we listed out the relationships we know, we would find that 1 ream = 5.0 kg, 1 ream = P102.50, and 1 kg = 1000 g. We will convert from grams to kilograms, then from kilograms to reams, then from reams to pesos:

$$\cancel{1 \text{ g}} \times \frac{\cancel{1 \text{ kg}} \times \cancel{1 \text{ ream}} \times \cancel{P102.50}}{\cancel{1000 \text{ g}} \quad \cancel{1 \text{ kg}} \quad \cancel{1 \text{ ream}}} = \text{P } 0.1025$$

DQ35. A car travels 55 miles every hour. What is its speed in cm per seconds. _____ cm/s

Example 3: How many milliseconds in 25 centuries?

There are 1000 ms in one second, 3600 s in one hour, 24 hours in a day, 365 days in a year, and 100 years per century:

$$\cancel{25 \text{ cent.}} \times \frac{\cancel{100 \text{ yr}} \times \cancel{365 \text{ d}} \times \cancel{24 \text{ hr}} \times \cancel{3600 \text{ s}} \times \cancel{1000 \text{ ms}}}{\cancel{1 \text{ cent}} \quad \cancel{1 \text{ yr}} \quad \cancel{1 \text{ d}} \quad \cancel{1 \text{ hr}} \quad \cancel{1 \text{ s}}} = 7.884 \times 10^{13} \text{ ms}$$

DQ36. How many seconds are there in 5 days? _____ s

Conversion of Temperature

Celsius to Fahrenheit	$(^{\circ}\text{C} \times \frac{9}{5}) + 32 = ^{\circ}\text{F}$
Fahrenheit to Celsius	$(^{\circ}\text{F} - 32) \times \frac{5}{9} = ^{\circ}\text{C}$
Kelvin to Celsius	$\text{K} - 273 = ^{\circ}\text{C}$
Celsius to Kelvin	$^{\circ}\text{C} + 273 = \text{K}$

Example 1

Convert 26° Celsius (*A nice warm day!*) to Fahrenheit

$$\text{First: } 26^{\circ} \times \frac{9}{5} = 234/5 = 46.8$$

$$\text{Then: } 46.8 + 32 = 78.8^{\circ} \text{ F}$$

Example 2

Convert 98.6° Fahrenheit (*Normal Body Temperature!*) to Celsius

$$\text{First: } 98.6^{\circ} - 32 = 66.6$$

$$\text{Then: } 66.6 \times \frac{5}{9} = 333/9 = 37^{\circ} \text{ C}$$

Example 3

Convert 12° C to Kelvin

$$\text{Just add: } 12^{\circ} \text{ C} + 273 = 285\text{K}$$

Example 4

Convert 44 ° F to Kelvin

$$\text{First: } 44^\circ \text{ F} - 32 = 12$$

$$\text{Next: } 12 \times 9/5 = 108/5 = 21.6^\circ \text{ C}$$

$$\text{Then: } 21.6^\circ \text{ C} + 273 = 294.6 \text{ K}$$

DQ37. Convert 34° Celsius to Fahrenheit (Write your solution below)

DQ38. Convert 122°Fahrenheit to Celsius (Write your solution below)

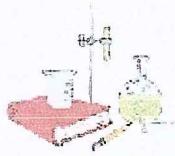
DQ39. Convert 56° C to Fahrenheit (Write your solution below)

DQ40. Convert 213 ° C to Kelvin (Write your solution below)

DQ41. Convert 41 °Fahrenheit to Kelvin (Write your solution below)

⊕ ENRICHING ACTIVITIES

1. Express the following numbers in scientific notation and report their number of significant figures.
 - a. 342,657,000,000,000,000,000
 - b. 0.000 000 000 000 000 874
2. Express the following numbers to 3 significant figures.
 - a. 0.0001243567
 - b. 0.00087678
 - c. 0.42
 - d. 8222
 - e. 1704
3. Convert the density of water (1.0 g/ml) to the units of lb/gal.

**Self-test**

Direction: Choose the best answer.

1. The term used to describe how consistently several measurements of some quantity give the same result is:
 - a. exactness.
 - a. accuracy.
 - b. uncertainty.
 - c. precision.
2. 47.0°C is ____ $^{\circ}\text{F}$.
 - a. 85.3
 - b. 58.1
 - c. 79.4
 - d. 117
3. The hottest part of the flame is
 - a. yellow flame
 - b. inverted light blue cone
 - c. tip of the flame
 - d. none of the above
4. The two properties combine to cause a liquid to "climb" the walls of a graduated cylinder and form a bend or dip on the surface of a liquid are
 - a. cohesion and adhesion
 - c. melting and boiling point

b. cohesion and condensation d. evaporation and adhesion

5. Room temperature is about

a. 75 °C c. 25 °F

b. 25 °C d. 30 °C

6. Two students, Garrison and Isabella, determine the mass of an object on two different balances. The accepted mass of the object was 2.355 g. Garrison obtained values of 2.531 g, 2.537 g, 2.535 and 2.533 g. Isabella obtained values of 350 g, 2.404 g, 2.296 g and 2.370 g. Which statement best describes the results that were obtained by Garrison and Isabella?

a. Garrison obtained better accuracy.

b. Isabella obtained better accuracy.

c. Garrison obtained better precision.

d. Isabella obtained better precision.

7. How many milligrams are in 0.2 decigrams?

a. 20 milligrams

b. 2000 milligrams

c. 0.002 milligrams

d. 0.00002 milligrams

8. Which of the following instruments is used to measure temperature?

a. Barometer

b. Thermometer

c. Ammeter

d. Balance

9. The mass of a metal cylinder was determined on an analytical balance to be 50.208 g. The volume of the cylinder was measured to be 5.6 mL. The density of the metal cylinder, expressed to the proper significant figures is

- a. 8.9657 g/mL
- b. 9.0 g/mL
- c. 0.11153 g/mL
- d. 0.11 g/mL

10. How many centimeters are there in 1.50×10^{-2} kilometers?

- a. 1.50×10^2
- b. 1.50×10^4
- c. 1.50×10^{-1}
- d. 1.50×10^3

Answers to Developmental Questions (Module 2)

DQ1. 13.15

DQ2. 7.35

Answers to DQ3 to DQ15 would depend on the results of the activity "Measuring Length, Temperature and Volume" conducted by the students and the measuring device used.

DQ16. 30 mL

DQ17. 15 mL

DQ18. 45mL

DQ19. 40 mL

Answers to DQ20 to DQ22 would depend on the experiment "Use of Balance" conducted by the students.

DQ23. qualitative

DQ39. 132

DQ24. quantitative

DQ40. 6.02217×10^{18}

DQ25. quantitative

DQ41. 4.2×10^{-16}

DQ26. qualitative

DQ42. 3.147×10^2 m

DQ27.	10 sig figs	DQ43.	$1.8 \times 10^{-3} \text{ m}$
DQ28.	6 sig figs	DQ44.	$6.4 \times 10^{-2} \text{ m}$
DQ29.	5 sig figs.	DQ45.	$8.8 \times 10^{-3} \text{ m}$
DQ30.	4 sig figs	DQ45.	$8.8 \times 10^{-3} \text{ m}$
DQ31.	4 sig figs	DQ46.	8.71×10^1
DQ32.	2 sig figs	DQ47.	4.36×10^8
DQ33.	5 sig figs	DQ48	1.55×10^{-2}
DQ34.	3 sig figs	DQ49.	9.01×10^3
DQ35.	2 sig figs	DQ50.	1.78×10^{-3}
DQ50.	1.78×10^{-3}	DQ51	6.30×10^2
DQ36.	4 sig figs	DQ52	$5.5 \times 10^{-5} \text{ kg}$
DQ37.	4 sig figs	DQ53.	$2.4 \times 10^3 \text{ cm/s}$
DQ38.	23.4	DQ54.	18 000 s

Answers to Self-test

1. d	6. b
2. b	7. a
3. b	8. b
4. a	9. b
5. b	10. d

FEEDBACK to Answers

You are **Outstanding!** If your score is 10.

Great! If you score 9 or 8.

Just fine! If you score 7 or 6.

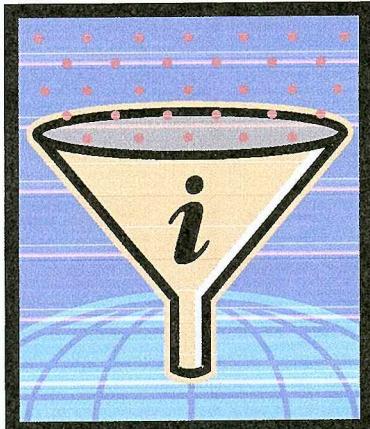
If you score 5 and below, **Study more.**

MODULE 3

STATES OF MATTER

Objectives:

1. Analyze examples of solids, liquids, and gases to determine their compressibility, structure, motion of particles, shape, and volume.
2. Distinguish between gases, liquids, and solids and explain how these states differ at the molecular level



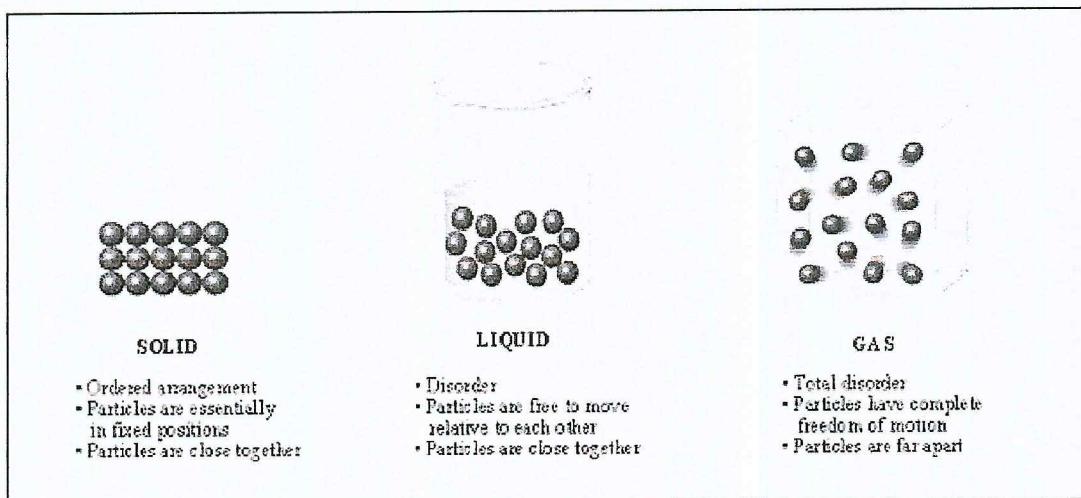


Figure 12. Phases of Matter

Matter exists in different physical forms known as states. The three common states of matter are solids, liquids, and gases. There is a fourth state known as plasma (ionized gas) found mostly inside stars. The properties of each state are best understood at the molecular level. The primary distinction between these phases deals with the attractions/forces between the atoms or molecules together.

Whether matter is liquid, solid, or gaseous depends on its temperature.

Generally, as a solid is heated (or as pressure decreases), it will change to a liquid form, and will eventually become a gas. For example, ice (frozen water) melts into liquid water when it is heated. As the water boils, the water evaporates and becomes water vapour.

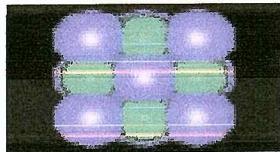
Sometimes, a solid will go directly from solid to gas - this is called *sublimation*. An example of sublimation is dry ice, the solid (frozen) form of carbon dioxide, CO_2 , which turns into gaseous carbon dioxide at standard temperature and pressure - there is no liquid phase of CO_2 at standard temperature and pressure.

SOLIDS have strong intramolecular (between molecules) forces that hold the atoms or molecules together. Each molecule interacts closely with those around it and has very little freedom to change position. Solids that have an ordered array of atoms/molecules are called *crystalline solids*. Those that have a long range order are called amorphous. An example of an amorphous solid is window glass. In addition many polymers such as polystyrene are amorphous. *Amorphous solids* can exist in two distinct states, the 'rubbery' state and the 'glassy' state.

A substance in a solid phase is relatively rigid, has a definite volume and shape. The atoms or molecules that comprise a solid are packed close together and are not compressible.

There are four types of crystalline solids --

Ionic solids -- These substances have a definite melting point

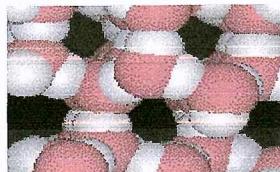


and contain ionic bonds. An example would be sodium chloride (NaCl).

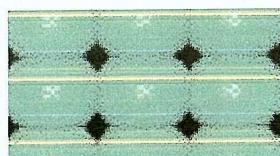
Covalent solids -- These substance appear as a single giant molecule made up of an almost endless number of covalent bonds. An example would be graphite.



Molecular solids --are represented as repeating units made up of molecules. An example would be ice.



Metallic solids--are repeating units made up of metal atoms.



The valence electrons in metals are able to jump from atom to atom.

Amorphous solids do not have a definite melting point or regular repeating units. An amorphous solid is a solid in which there is no long-range order of the positions of the atoms unlike those in crystalline solids.

LIQUIDS have somewhat weaker interactions between the atoms or molecules. The molecules can move fairly freely past one another, and the material will tend to take the shape of its container. Examples of liquids include drinking water, mercury at room temperature, and lava (molten rock).

Liquids have a definite volume, but are able to change their shape by flowing. Liquids are similar to solids in that the particles touch. However the particles are able to move around. Since particles are able to touch the densities of liquid will be close to that of a solid. Liquid molecules can move they will take the shape of their container.

The pull on the surface of liquids that allow liquids to form drops when they fall is called *surface tension*.

GASES have little or no interactions between the atoms or molecules . The distance between adjacent molecules is many times larger than in liquids and solids. Gases generally diffuse, spacing themselves throughout the container.

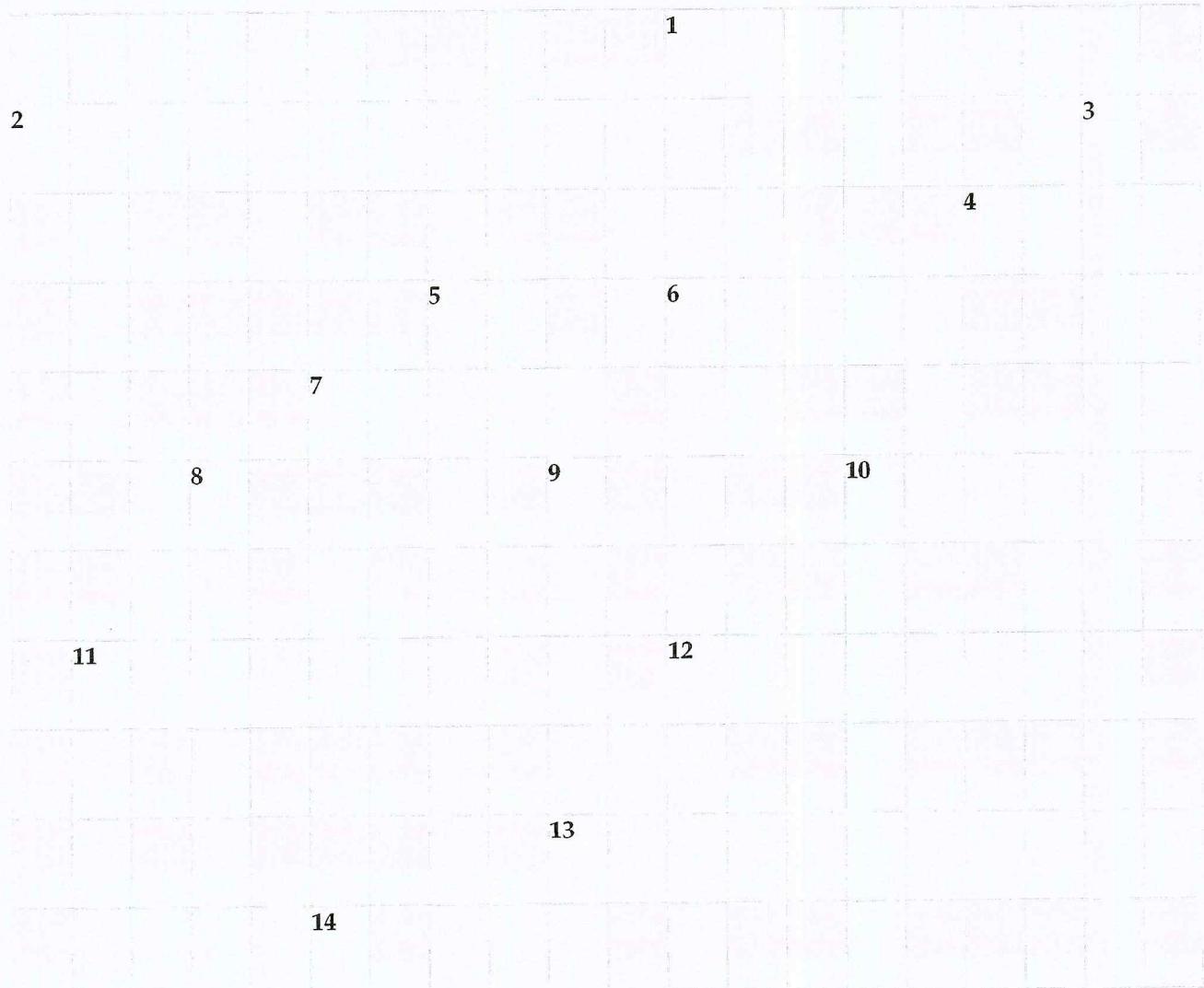
Examples of gases include the gases we breathe (nitrogen, oxygen, and others), the helium in balloons, and steam (water vapor).

Gases have no definite volume or shape. If unconstrained gases will spread out indefinitely. If confined they will take the shape of their container. This is because gas particles have enough energy to overcome attractive forces. Each of the particles are well separated resulting in a very low density.

PROPERTIES	Kinetic Molecular Theory Explanation
GASES	
<ul style="list-style-type: none"> • Indefinite volume • Low density • Easily compressed • Exert pressure equally in all directions on any surface. • Mix spontaneously 	<ul style="list-style-type: none"> • Particles move rapidly in all directions; very weak force of attraction between them • Particles are widely separated; few particles in a given volume • Particles are so small and far apart, they can be easily forced to get closer by an outside pressure • Particles move rapidly and randomly in all directions • Particles are relatively far apart so that there is enough distances between them to allow molecules to diffuse
LIQUIDS	
<ul style="list-style-type: none"> • Definite volume, indefinite shape 	
<ul style="list-style-type: none"> • Cannot be compressed • Ability to flow 	<ul style="list-style-type: none"> • Molecules are held by intermolecular forces of attraction; weak enough to allow them to move freely but strong enough to keep them close together for a definite volume. • Distance between molecules is relatively small • Intermolecular forces are weak enough to allow them to flow
SOLIDS	
<ul style="list-style-type: none"> • Definite volume, rigid shape • Higher density than liquids and gases; • cannot be compressed 	<ul style="list-style-type: none"> • Strong forces of attraction between particles • Particles are so close together and held tightly that they cannot move freely but vibrate in fixed direction

ACTIVITY 3.1

States of Matter Crossword Puzzle



15

16

17

18

19

20

21

22

23

24

down 1.down 3.down 5.down 8.

The three forms of matter
(liquid, solid, and gas). (3 matter from a solid to a
words)

down 9.down 11.down 14.down 15.

The change in a state of
matter from a gas to a
liquid.

If you add heat to matter, In ____, atoms move the
the atoms that make up
the matter will begin to
move ____.

down 16.down 19.down 20.down 21.

The particles in ____
move back and forth in
place.

across 1.

The particles in liquids
past each other.

across 2.

A solid always take up
the same amount of this.

across 4.

A state of matter that has
no fixed shape and no
fixed volume.

across 6.

If you subtract heat from
matter, the atoms that
make up the matter will
begin to move ____.

The temperature at which
a given substance will
change from a liquid into
a gas. (2 words)

The particles in a solid
state move around ____

The number of states of
matter.

across 7.across 10.across 11.across 12.

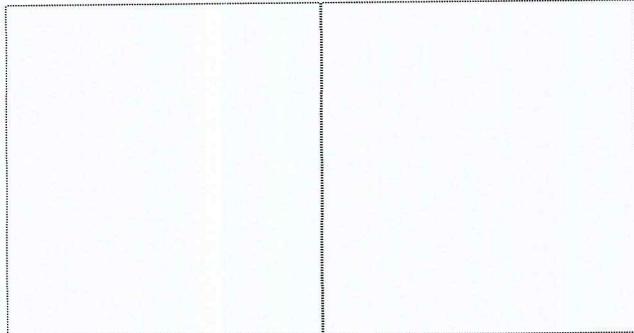
You can change the state of matter by either adding or subtracting _____. A state of matter that has no fixed shape but that has a definite volume. Particles in a gas are _____ apart than the particles in a liquid. The change in a state of matter from a liquid to a solid.

across 13.across 17.across 18.across 22.

The change in a state of matter from a liquid to a gas. The pull on the surface of liquids that allow liquids to form drops when they fall. (2 words) The basic building blocks of matter. The temperature at which a given substance will change from a solid into a liquid. (2 words)

across 23.across 24.

A state of matter that has a definite shape and a definite volume. Gases _____ to fill whatever space is available to them.



ENRICHING ACTIVITIES

Compare the molecular structure of solids, liquids and gases using the Kinetic Molecular Theory.



Self-test

Direction: Choose the best answer.

1. Which of the following statements best describes the arrangements of particles in a liquid?
 - a. far apart and vibrating
 - b. very far apart and moving quickly
 - c. close together and stationary
 - d. close together and moving freely

2. Which of the following statements concerning molecules in the liquid state is true?

- a. The molecules contract to fit the size of the container
- b. The molecules have no motion
- c. The molecules are in a patterned (oriented) arrangement
- d. The molecules are mobile and relatively close together

3. Which of the following statements best describes the arrangement of particles in a solid?

- a. far apart and vibrating
- b. very far apart and moving quickly
- c. close together and stationary
- d. close together and moving freely

4. Which of A to D describes cooking oil?

- a. a solid
- b. a liquid
- c. a gas
- d. difficult to classify simply as gas, liquid or solid

5. Which of A to D describes carbon dioxide?

- a. a solid
- b. a liquid
- c. a gas
- d. difficult to classify simply as gas, liquid or solid

6. Which of these is a solid?

- a. ice
- b. helium
- c. oxygen
- d. petrol

7. Solids such as salt and sugar dissolve more readily in:

- a. hot water
- b. cool water
- c. iced water
- d. lukewarm

8. Which state of matter does not completely fill its container and has no definite shape of its own?

- a) gas
- b) liquid
- c) solid
- d) none of these

9. Which state of matter is most easily compressed?

- a) gas
- b) liquid
- c) solid
- d) all are the same

10. Which of the following properties do liquids and gases have in common?

- a) they expand slightly on heating
- b) they will flow
- c. they are easily compressed
- d.) they expand to fill their contain.

Answer to Crossword Puzzle: States of Matter (Module 3)

Answer Key

							1	S	L	O	W	E	R						
2	B	O	I	L	I	N	G	P	O	I	N	T	3	M					
									A				4	O	N	E			
																L			
							5	W		6	T	H	R	E	E				
																T			
			7	H	E	A	T		E										
			8	S			T	9	C	S		10	L	I	Q	U	I	D	
																		N	
			P				E	O	O										
11	F	A	R	T	H	E	R		N	12	F	R	E	E	Z	I	N	G	
A		E			V		D		M										
S		A			A		13	E	V	A	P	O	R	A	T	I	O	N	
T		D	14	G		P		N		T									
E					A	O		S		T	15	Z						16	S

R	17	S	U	R	F	A	C	E	T	E	N	S	I	O	N		
		E				T		R		R				L			
18	A	T	O	M	S			I			O			I			
							19	S	O	20	S			D			
21	G		22	M	E	L	T	I	N	G	P	O	I	N	T	S	
		A			I					A							
23	S	O	L	I	D					C							
						E					24	E	X	P	A	N	D

Answers to Self-test

1. d	4. b	8. a
2. d	5. c	9. a
3. c	7. a	10. a

FEEDBACK to Answers

You are **Outstanding!** If your score is 10.

Great! If you score 9 or 8.

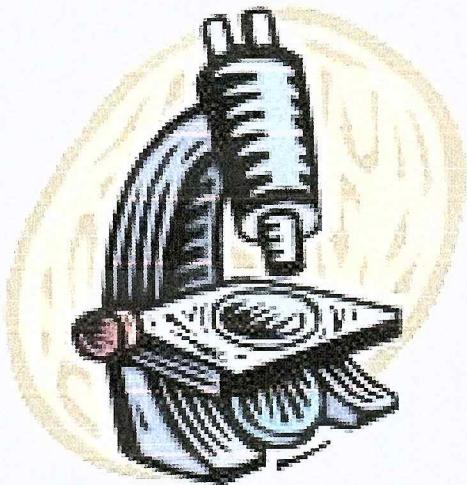
Just fine! If you score 7 or 6.

If you score 5 and below, **Study more.**

MODULE 4

THE PROPERTIES OF MATTER

Objectives:



At the end of the module, you are expected to:

1. To distinguish between physical and chemical properties of matter.
2. To determine between intensive and extensive properties of matter.
3. To determine some distinguishing properties of matter.

Why is a pencil different from a ball pen? A piece of paper from a piece of cloth? Mongo from meat? Copper from wood? What in fact one kind of matter different from another? Different kinds of materials differ from one another in characteristics and behavior. These characteristics and behavior are called *properties of matter*. These properties may be physical or chemical.

ACTIVITY 4.1

Physical Properties of Matter

You will need the following apparatus and chemicals on this activity:

beaker	burner	iron wire
hammer	magnet	lumps of charcoal
mortar and pestle	test tubes	salt
vials	balance	sugar

Procedures:

1. Take a sample of iron wire, lumps of charcoal, salt and sugar.
2. Observe the sample carefully using as many senses as you can.
3. Record your observations below:

Substance	Length (cm)	Mass (g)	Smell	Taste	Color	Appearance
Iron Wire						
Charcoal						
Salt						
Sugar						

4. Place some of the solid sample on a 2-inch square piece of paper and place it on the left pan of the balance.

5. Adjust the weight till the beam is level.

DQ1. What property does this indicate? _____

6. Take a small vial and place some of the sample in it. Continue adding the material.

DQ2. Can you add this indefinitely? _____

DQ3. What property of matter does this indicate? _____

7. Place a magnet near each substance. DQ4. What happens?

8. Place a sample amount of the substance in a mortar and try to crush it with the pestle. If the pestle does not affect it, take the sample out, pound it with a hammer. Observe.

9. Heat the sample. DQ5. Do you notice any change? _____

DQ6. What properties are common to all samples of matter?

DQ7. Which properties differ among the samples?

DQ8. Are the properties constant to one also constant to another sample? _____

DQ9. Compare the constant properties of the samples. Are they the same or not? _____

The measurement of mass and other characteristics that can be seen without changing how that object looks are its physical properties. When you look at oranges, you know that they are oranges because of their color, shape, and smell. Mass, color, shape, volume, and density are some physical properties. The answers to the question about the present are *physical properties*.

Physical properties are those which can be determined without changing the identity of the materials and is dependent on the amount of a substance. They include shape, volume, mass, density, hardness, ductility, malleability, boiling point and melting point.

Physical properties may either be *intensive* or *extensive*. Weight, volume, shape, temperature, and radius are examples of *extensive properties*. Intensive properties are physical properties which are dependent on the nature of the substance. Color, odor, hardness, boiling point, melting point, density are examples of *intensive properties*.

Chemical properties are properties that can only be observed by changing the identity of the substance. A piece of paper burns and turns to a black

substance. After the flame goes out you can no longer burn the new substance.

The chemical properties have been changed.

Properties are constantly changing...

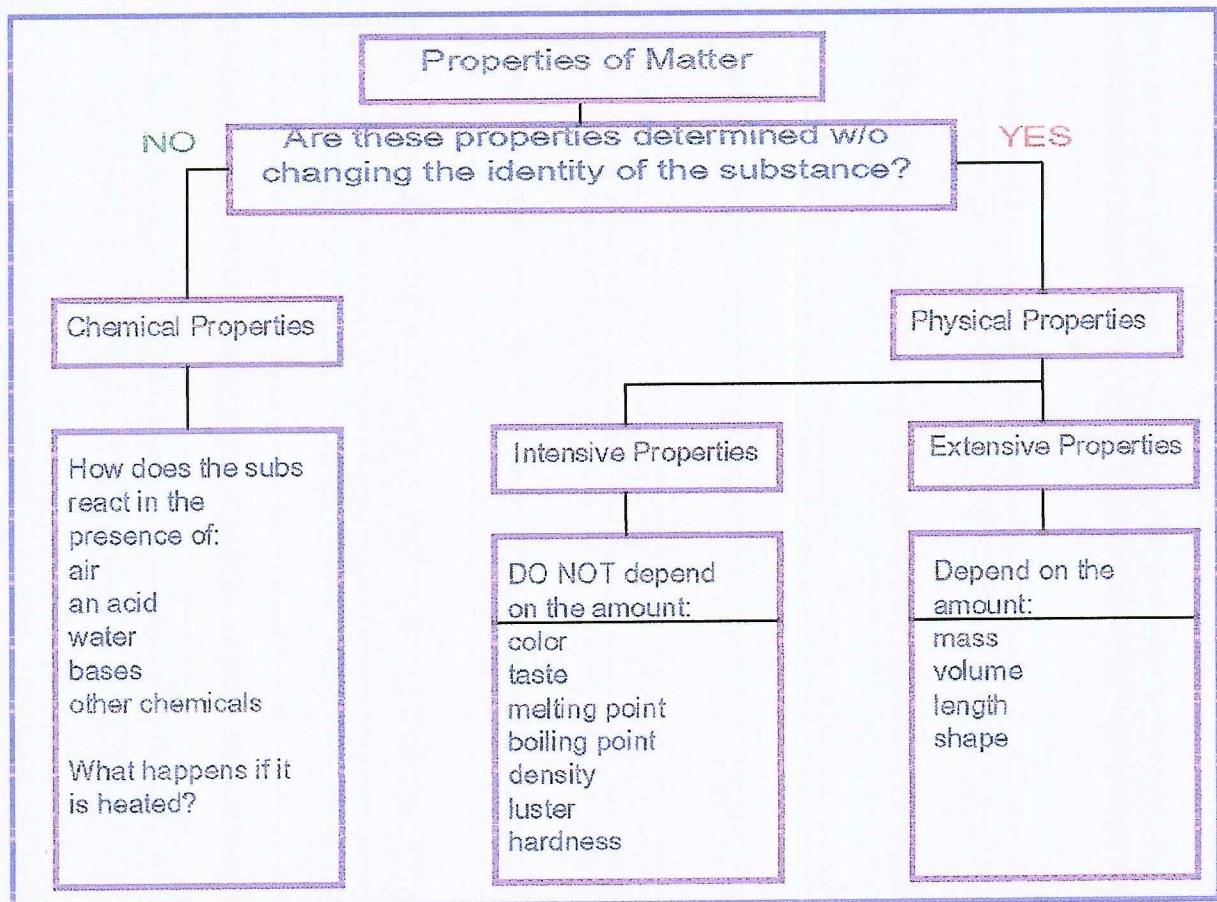


Figure 13. Properties of Matter

Examples:

Physical properties (25°C)	Chemical Properties
Appearance: a soft, shiny metal	forms an oxide Na_2O and a hydride NaH
density: 0.97 g cm^{-3}	burns in air to form sodium peroxide Na_2O_2
melting point: 97.5°C	reacts violently with water to release hydrogen gas
boiling point: 960°C	dissolves in liquid ammonia to form a deep blue solution

Classify each of the statements as a physical or chemical property, and explain the basis for your answer.

Examples:

Chlorine is a greenish-yellow gas at room temperature.

Physical property

Gold is highly resistant to corrosion.

Chemical property

DQ20. Liquid oxygen is attracted to magnet.

DQ21. Hydrogen cyanide is an extremely poisonous gas.



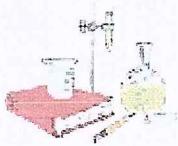
ENRICHING ACTIVITIES

1. Compare and contrast extensive and intensive properties
2. Classify each of the following properties of matter as physical [P] or chemical [C].

a. Color _____	f. Reacts violently with chlorine _____
b. Density _____	g. Good conductor of heat _____
c. Burns easily (flammable) _____	h. Dissolves readily in water _____
d. Not affected by acids _____	i. Melts at 145 °C _____
e. Boils at 450 °C _____	j. Malleable _____

3. Classify each of the following as extensive or intensive property.

a. the volume of beer in a mug _____
b. the number of calories of energy you derive from eating a banana _____
c. the mass of iron present in your blood _____
d. the pressure of air in a bicycle tire _____
e. the electrical resistance of a piece of 22-gauge copper wire _____



Self-test

Direction: Choose the best answer.

1. Which of the following properties is an example of an EXTENSIVE property of a material?
 - a. density
 - b. mass
 - c. reactivity with oxygen
 - d. temperature

2. Which of the following property is NOT an intensive property of a material?
 - a. density
 - b. color
 - c. combustible
 - d. melting point

3. Which of the following property is an intensive property of a material?
 - a. energy
 - b. volume

c. density

d. mass

4. Below are five properties concerning a sample of elemental gallium.

Which of the following answers specifies all the intensive properties?

I. The temperature of the sample is 18°C.

II. The mass of the sample is 16.2 grams.

III. The volume of the sample is 2.74 cm³.

IV. The density of the sample is 5.9 g/cm³.

V. The sample reacts readily with fluorine.

a) I and IV

b) IV and V

c) II and III

d) I, IV, and V

5. Which of the following properties about bromine is a chemical property?

a. The density of Br is 3.12 g/cm³ at 293 K

b. Br is a brown liquid that boils at 332 K

c. Br reacts rapidly with metals

d. Br is a reddish/brown liquid

6. Which response list all of the following properties of sulfur that are physical properties and not other properties.

- I. It reacts with hydrogen when heated.
- II. It is yellow solid at room temperature.
- III. It is soluble in carbon disulfide.
- IV. Its density is 2.97 g/cm³
- V. It melts at 112 °C
 - a. II, III, IV and V
 - b. II, IV, and V
 - c. I
 - d. II, III, and IV

7. Which of the following best explains the physical property of matter?

- a. It depends on the amount and nature of the substance.
- b. It can be observed when it undergoes chemical reaction.
- c. It cannot be separated by ordinary means.
- d. It produces a new substance.

8. A sheet of paper is cut. Which statement is true?

- a. It changes into a different material.
- b. Its size and shape change.
- c. It loses its identity.
- d. The composition changes.

9. Which of the following statement is CORRECT?

- a. melting a piece of lead: intensive property
- b. rock is crushed into small pieces: intensive property
- c. colored clothes fade when bleached under the sun: extensive property
- d. aluminum is rolled into thin sheets: extensive property

10. Which is a physical property of the element zinc?

- a. It forms a white solid when heated in air
- b. It melts when heated in an empty, sealed container
- c. When put into dilute hydrochloric acid, bubbles of hydrogen gas forms
- d. It exhibits no change when placed in water in room temperature

Answers to Developmental Questions

DQ1. Mass

DQ2. Yes

DQ3. Volume

DQ4. The iron wire was attracted to the magnet while the sugar, charcoal and salt did not.

DQ5. Yes, the iron wire melted while sugar and salt turns into a black substance.

DQ6. Mass and Color

DQ7. They differ in length, volume, shape and mass.

DQ8. Yes, there are properties which are constant to one and constant to another such as color.

DQ9. Sugar and salt are the same in color which is white.

DQ10. Extensive; depends on the volume of blood in the body.

DQ11. Intensive; the same for any 5-mL sample

DQ12. Extensive; depends on the length of the wire

DQ13. Intensive; same for any 1-km length of the same wire

DQ14. Pressure itself is intensive, but it is also dependent on the quantity of air in the tire.

DQ15. No, they are totally different.

DQ16. A new substance is formed.

DQ17. No.

DQ18. Yes.

DQ19. Yes.

Answers to Self-test

1. d or b

2. c

3. c

4. b

5. c

6. b

7. b

8. b

9. d

10. b

FEEDBACK to Answers

You are **Outstanding!** If your score is 10.

Great! If you score 9 or 8.

Just fine! If you score 7 or 6.

If you score 5 and below, **Study more.**

MODULE 5

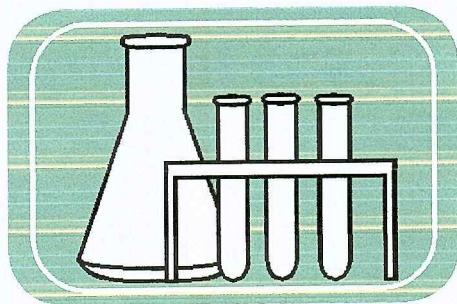
CHANGES OF MATTER

Objectives:

At the end of this module, you are expected

to:

1. To be able to identify the types of changes matter undergoes.
2. To be able to differentiate physical change from chemical change.
3. To describe what happens to substances that undergo chemical change.



ACTIVITY 5.1

Changes Matter Undergoes

In this activity you will be able to identify the types of changes matter undergoes. You will be given a separate sheet where you will write your observation.

Materials:

hydrochloric acid	or	magnesium ribbon
sulfuric acid		baking soda
alcohol lamp		vinegar
test tubes		milk (liquid)
medicine dropper		mossy zinc or iron fillings
graduated cylinder		aluminum sulfate
ammonium hydroxide		denatured alcohol
water		a piece of plastic
scissor		

Procedures:

1. Place a few drops of denatured alcohol on a watch glass. Set it aside for a few minutes and observe.
2. Heat 1-cm magnesium ribbon directly over a flame. Use a pair of tongs to hold the magnesium ribbon.
3. Heat strongly a small amount of sugar in a test tube.
4. Add a pinch of iron fillings (or mossy zinc) to a 5 mL dilute hydrochloric acid (or sulfuric acid) in a test tube.
5. Mix a pinch of sugar in 5ml of water.
6. Add a liquid milk drop by drop using a medicine dropper to a 10 mL vinegar in a test tube.
7. To 5 ml of water in a test tube, slowly add 1 mL of concentrated sulfuric acid. (Always remember that acid should be added to water and not the other way around.)
8. Put one teaspoon of baking soda in a dry test tube. Add 5 mL of vinegar.
9. Cut the piece of plastic using a scissor into small pieces.

DQ1. Write your observations below and your idea of the type of reaction that undergo a chemical or physical change.

SUBSTANCES	OBSERVATION	TYPE OF CHANGE
Alcohol		
Magnesium and Water		
Heated Sugar		
Sugar and Water		
Mossy zinc and Water		
Iodine and Mercury		
Conc. Sulfuric acid and Water		
A Piece of Plastic		

A ripe guava on a tree is definitely ready to be eaten. But many other materials we need are not ready to use in the state at which they exist in nature. We have to deliberately bring about some changes so that we can use them. For instance, we cook meat to make it easy, tasty and pleasant to eat; we mold and bake clay before it can be used as pots, jars or plates; we extract iron from its ore before we can use it as building material.

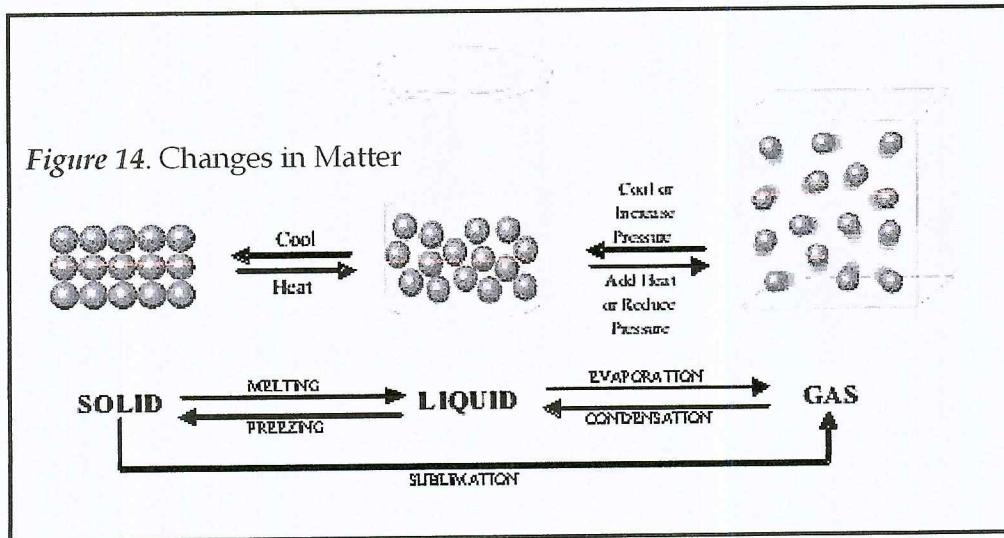
A. PHYSICAL CHANGES OF MATTER

The states of matter (solid, liquid, gas) are sometimes referred to as phases of matter. Matter can change phases and not change composition; this is known as a physical change. The key word is physical, because things only move from one phase to another by physical means. If energy is added or if energy is taken away, substances can be made to physically change into the different phases of matter.

Example of physical change of matter is change in size or shape such cutting of sheet into several pieces, breaking of glass or molding clay into different shapes. Another example is the change in state which includes melting, freezing, vaporization, condensation and sublimation.

- **MELTING** (Phase Change Solid to Liquid) What happens when you leave an ice cube out in the sun? It begins to melt. Melting is the change from a solid phase to a liquid phase. The range of temperatures at which a solid becomes a liquid is called the melting point.
- **FREEZING** (Phase Change from Liquid to Solid) Freezing is the change from the liquid to the solid phase. The range of temperatures at which a substance changes from a liquid to a solid is the freezing point.

- **SUBLIMATION** (Phase Change from Solid to Gas) Some solids are able to go straight to the gas phase without becoming a liquid (think of the smoke coming off dry ice). This process is called sublimation.
- **VAPORIZATION** (Phase Change from Liquid to Gas) Vaporization and Evaporation generally refer to the change of liquid into a gas. The range of temperatures at which a substance changes from a liquid to a gas is the boiling point. Vaporization and evaporation are the same change of states.
- **CONDENSATION** (Phase Change from Gas to Liquid) Condensation is the change of a substance from the gaseous phase to the liquid phase (See Fig. 14). The range of temperatures at which a gas becomes a liquid is known as the condensation point.



B. CHEMICAL CHANGES IN MATTER

We just discussed that matter can change physically, but we also know that it can change chemically. In chemical changes, a substance is transformed into a chemically different substance. Physical changes involve mostly a change in the spacing and order of particles (change of state), whereas chemical changes involve a rearrangement of particles into new combinations. The newly rearranged substances generally cannot be changed back to their original constituents.

To distinguish between physical and chemical changes, ask yourself if the change altered the identity of the substance. Generally the characteristics and properties (both physical and chemical) of the substance will have changed. For example, rust is visibly different from iron because it is red and powdery instead of shiny and hard. Furthermore iron conducts electricity, rust does not (change in chemical property). Common clues that can help identify if a chemical reaction has taken place include:

- ❖ *Change in color* such as when paper turns black when burned.
- ❖ *Production of light and heat* in candle burning or an explosion.
- ❖ *Production of gas bubbles* such as when baking soda bubbles when mixed with vinegar..
- ❖ Distinct change in odor , texture, appearance and taste like in cooking and digestion of food.

- ❖ If something can corrode such as rusting of metals
- ❖ Production of mechanical or electrical energy such as in a dry cell
- ❖ Formation of a precipitate. A precipitate is an insoluble solid which separates from a solution.

Now let us have another activity.

ACTIVITY 5.2

Physical and Chemical Change

Instruction:

DQ2. Identify which of the examples below are physical changes and which are chemical changes. Tabulate your answers as follows. Indicate your answer by putting a check mark in the appropriate blanks.

CHEMICAL SYSTEM	Involves Physical Change	Involves Chemical Change
a. Preparation of cheese.		
b. Manufacture of alcohol from sugar cane		
c. Plants grow.		
d. Water boils.		
e. Fireflies produce light		
f. Metal rusts.		
g. Sugar from sugarcane		
h. Bread gets moldy.		
i. Seeds germinate		
j. Water freezes.		
k. Clay is molded into pots.		
l. Coconut water ferments.		
m. Water evaporates.		
n. Paper cut into pieces.		
o. Leaves decay		

ENRICHING ACTIVITES

1. What are the evidences of chemical change?
2. Classify the following as chemical (C) or physical (P) changes.

<input type="checkbox"/> a. grapes fermenting	<input type="checkbox"/> f. burning gasoline
<input type="checkbox"/> b. copper melting	<input type="checkbox"/> g. hammering gold into foil
<input type="checkbox"/> c. recycling aluminum	<input type="checkbox"/> h. melting ice
<input type="checkbox"/> d. gasoline exploding	<input type="checkbox"/> i. digesting food
<input type="checkbox"/> e. grinding chalk into powder	<input type="checkbox"/> j. making hydrogen from water

**Self-test**

Direction: Choose the best answer. Encircle the letter of your answer.

1. Which of the following exhibits a physical change?
 - a) Na tends to give up an electron to form ionic compounds.
 - b) Na has a high electrical conductivity.
 - c) Na, when dropped into water, causes the evolution of H_2 gas.
 - d) Na reacts violently with oxygen.
2. Which of the following properties of water is chemical change?
 - a) Water boils at $100^\circ C$ under atmospheric pressure conditions.
 - b) Water reacts violently with alkali metals causing the evolution of H_2 gas
 - c) Pure water has a very low electrical conductivity.
 - d) The density of liquid water is slightly higher than that of solid water.
3. Which of the following properties of magnesium is a physical change?
 - a) Develops a thin oxide coating when left exposed to air.
 - b) Reacts with oxygen slowly at room temperature to produce magnesium oxide.
 - c) Reacts rapidly with oxygen at high temperature in a flame to

produce Mg oxide.

d) Has a bright silvery color in its metallic form when freshly made.

4. Which of the following is a chemical change involving silver?

- It conducts an electric current.
- It turns black when exposed to sulfur.
- It boils at 212°C
- Molten silver freezes at 962°C.

5. When one or more substances produce one or more other substances that differ in chemical properties from the original substances, then

- a physical change has taken place
- a chemical change has taken place
- a phase change has taken place
- a change in total mass has taken place

6. Of the following properties of sucrose, which one is a chemical property?

- It dissolves in water.
- It is a white solid.
- It has a density of 1.587 g/cm³.
- Upon heating in air, it turns black and emits a caramel odor.

7. Which of the following properties is a physical change?

- gas is generated from manure
- distillation of water

- c. digestion of food in the body
- d. fermentation of fruit juice to wine

8. Which of the following is a chemical change?

- a. rock is crushed into small pieces
- b. gasoline evaporates when left in an open dish
- c. colored clothes fade when bleached under the sun
- d. aluminum is rolled into thin sheets

9. The following are example of physical change except ONE

- a. melting of ice cream
- b. baking soda produces gas when added with water
- c. breaking of glass
- d. molding clay into different shapes

10. The phase change represented by the equation $I_2(s) \longrightarrow I_2(g)$ is called

- a. sublimation
- b. condensation
- c. melting
- d. boiling

Answers to Development Questions

DQ1.

Activity 4.1

SUBSTANCES	OBSERVATION	TYPE OF CHANGE
Alcohol	It evaporates.	Physical Change
magnesium ribbon	It turns to a black substance.	Chemical Change
heated sugar	It turns into a black substance.	Chemical Change
sugar and water	Sugar dissolves in water.	Physical change
mossy zinc and water	It bubbles.	Chemical Change
iodine and mercury	It bubbles.	Chemical Change
conc. Sulfuric acid and water	It produces a gas.	Chemical Change
a piece of plastic	The plastic reduces its size.	Physical Change

DQ2.

Activity 4.2

CHEMICAL SYSTEM	Involves Physical Change	Involves Chemical Change
a. Preparation of cheese.		/
b. Alcohol from sugar cane.		/
c. Plants grow.		/
d. Water boils.	/	
e. Tocino from meat		/
f. Metal rusts.		/
g. Sugar from sugarcane		/
h. Bread gets moldy.		/
i. Seeds germinate		/
j. Water freezes.	/	
k. Clay is molded into pots	/	
l. Coconut water ferments		/
m. Water evaporates.	/	
n. Paper cut into pieces.	/	
o. Leaves decay		/

Answers to Self-test

1. b

2. b

3. d

4. b

5. d

6. b

7. c

8. d

9. b

10. a

FEEDBACK to Answers

You are **Outstanding!** If your score is 10.

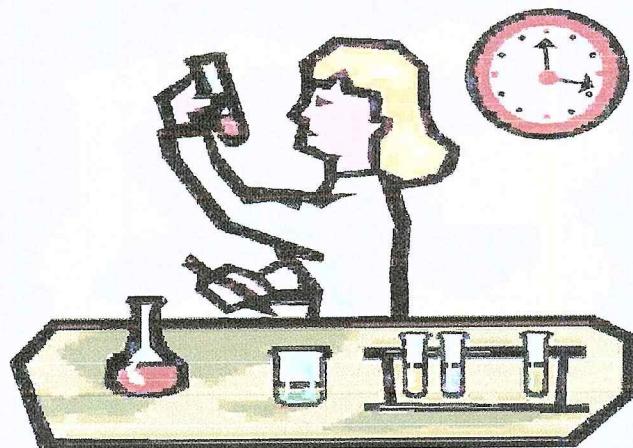
Great! If you score 9 or 8.

Just fine! If you score 7 or 6.

If you score 5 and below, **Study more.**

MODULE 6

CLASSIFICATION OF MATTER



Objectives:

At the end of this module you are expected to:

1. Classify matter into elements, compounds and mixtures by describing their physical and chemical properties.
2. Classify metal from nonmetal.

Matter is anything with mass. All matter is made up of particles. Energy on the other hand is the capacity to do work. It has no mass.

Matter is generally classified into two groups namely the *homogeneous substance* and *heterogeneous mixtures*. Homogeneous substance is one in which only one phase is present. It includes solution and pure substances. The heterogeneous mixture on the other hand is one in which the component parts can be detected.

A mixture, in contrast, is composed of two or more substances and it can exhibit a wide range of properties depending on the relative amounts of the components present in the mixture. For example, you can dissolve up to 357 grams of salt in one liter of water at room temperature. For each of these concentrations, properties such as density, boiling and freezing point of the resulting solution will be different.

One other difference between a mixture and a compound is that a mixture can be separated by ordinary chemical means, whereas a compound cannot. Common processes for separating mixtures include filtration, decantation, distillation, boiling point and freezing.

Example Out of the following, which are examples of matter?

1. granite rock	11. bread
2. laser beam	12. burger
3. oxygen	13. coffee and sugar mixture
4. air	14. carbon

5. brine	15. carbon monoxide
6. sulfur	16. banana
7. sulfur dioxide	17. gold
8. tomato salad	18. salt
9. tin can	19. acetic acid
10. soil	20. water

DEFINITIONS:

A. *Homogeneous Substance*: has the same composition and properties throughout ; has only one phase or compounds throughout. If you observed a homogeneous mixture under a microscope, you would see that the particles of various components are evenly distributed.

Examples DQ1(*choose from examples given*) _____

B. *Heterogeneous mixture*: has a variable composition. It is made up of substances that have different properties. You can actually see the different substances that make up the mixture. Substances in a heterogeneous mixtures are not evenly distributed.

Examples DQ2(*choose from examples given*) _____

C. *Solution*: a homogeneous mixture. It seems to be just one substance but you can separate it into 2 or more substances without using a chemical reaction, for example by letting the liquid evaporate.

Examples DQ3(*choose from examples given*) _____

D. *Pure Substance*: homogeneous substances that can only be taken apart by chemical means, that is by getting them to explode or decompose into new substances with completely different properties. The rest can only be taken apart by nuclear reactions. It consists of one particular kind of matter, having only one phase. Phases may be solid, liquid or gas. Having uniform properties throughout the system is one characteristic of a pure substance.

Examples DQ4(*choose from examples given*) _____

E. *Element*: a pure substance with only one kind of atom. An element cannot be made into something simpler through a physical or chemical reaction. The formula of an element contains only one capital letter. An element may be divided into two classes namely metals and nonmetals. A metal is an element that in general has a characteristic luster, conducts heat and electricity as well, and can be pounded into various shapes without breaking. A nonmetal, on the other hand, is an element that is not lustrous, is a poor conductor of heat and electricity, and is brittle in a solid state.

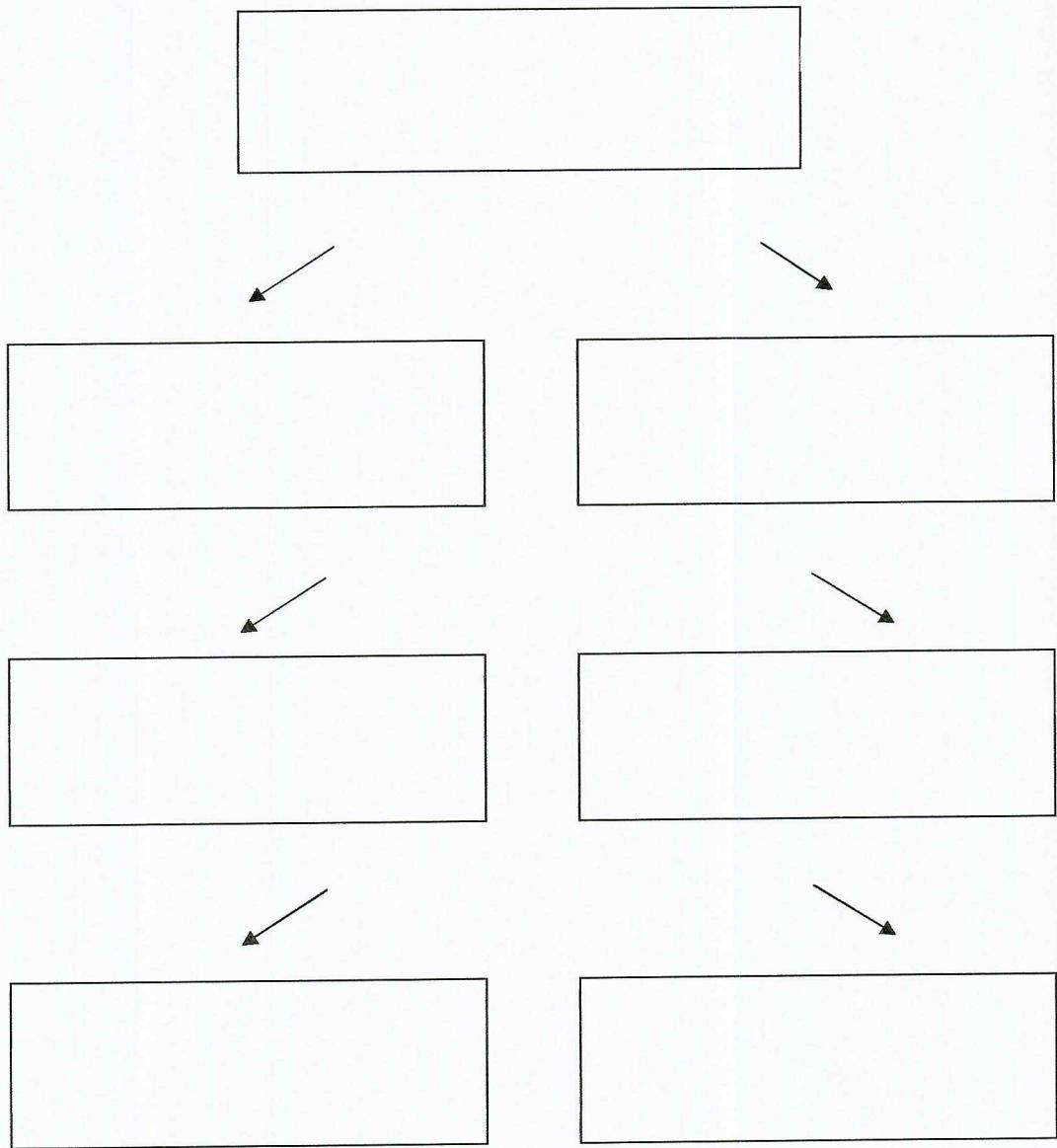
Examples DQ5(*choose from examples given*) _____

F. **Compound** is a pure substance with more than one kind of atom, so that the formula of a compound consists of more than one capital letter. In order to break up a compound, it must undergo a chemical reaction as described in definition D. The formula for a compound gives the elements (or atoms) that is composed of and the relative proportions of these atoms. For example, the compound water is composed of two atoms of hydrogen and one atom of oxygen; therefore the formula for water is H_2O . The Law of Definite Proportions or Constant Proportions states that any pure compound always contains the same elements in exactly the same proportions by mass (weight).

Examples DQ6 (*choose from examples given*) _____

DQ7 Complete the following chart, using definitions A through F.

Summary Within a Chart



ACTIVITY 6.2

Metal and Non-metal

You will need the following to do this activity:

Bunsen Burner

Sandpaper

Carbon rod

Copper wire

Hammer

Procedure:

1. Get a piece of carbon rod and a 15 cm copper wire. Clean the copper wire with sand paper.
2. Observe the appearance of both carbon rod and copper wire.

DQ8. Which of the two has luster? _____.

3. Hold end of the copper wire, heat the other end for a few seconds.

Do likewise with the carbon rod.

DQ9. Which of the two transmits heat? _____.

4. Hammer both elements.

DQ10. What happens to the carbon rod? _____.

DQ11. What happens to the copper wire? _____.

The copper wire used in this activity is an example of a metal. It has luster similar to that of silver. It is malleable and conducts heat and electricity. The carbon rod on the other hand, is an example of a non-metal. It has no metallic luster. It is brittle. It is a poor conductor of heat and electricity.

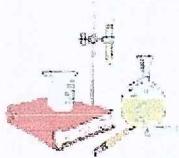
ENRICHING ACTIVITIES

1. Answer the following questions with true or false.

1. Chicken noodle soup is not a solution.
2. Oxygen is a compound.
3. Salad is a heterogeneous mixture.
4. Table salt is a substance.
5. Chlorine is not an element.
6. Salt water is an element.
7. Chicken noodle soup is not a heterogeneous mixture.
8. Fluorine is a solution.
9. Potato chips are a homogeneous mixture.
10. Sand is a compound.

2. Classify each of the following substances as; an element, a compound, a solution, or a heterogeneous mixture.

1. Pure Air	6. Pure water
2. Gold	7. Salt
3. Salt Water	8. Mercury
4. Sand	9. Oxygen
5. Carbon Dioxide	10. Petroleum

**Self-test**

Direction: Choose the best answer.

1. Which chemical system is homogeneous?

- a. sand and stone
- c. coffee in hot water
- b. halo-halo
- d. oil and water

2. A violet solid substance was heated. A gas evolved and a white crystalline solid was produced. How do we classify the original substance?

- a. an element
- c. a metal
- b. a compound
- d. a nonmetal

3. A substance is observed to have luster and is malleable when hammered. What kind of substance is it?

- a. nonmetal
- c. colloid
- b. metal
- d. solution

4. Of the following names/symbol combination of elements, which one is WRONG?

- a. Uranium/U
- c. Nitrogen/N
- b. Sulfur/S
- d. Iron/I

5. Identify the INCORRECT statement?

- a. Helium in a balloon: an element
- b. Salt: a mixture

Answers to Developmental Questions

DQ1. brine, coffee with sugar mixture DQ8. copper wire

DQ2. granite rock, air DQ9. copper wire

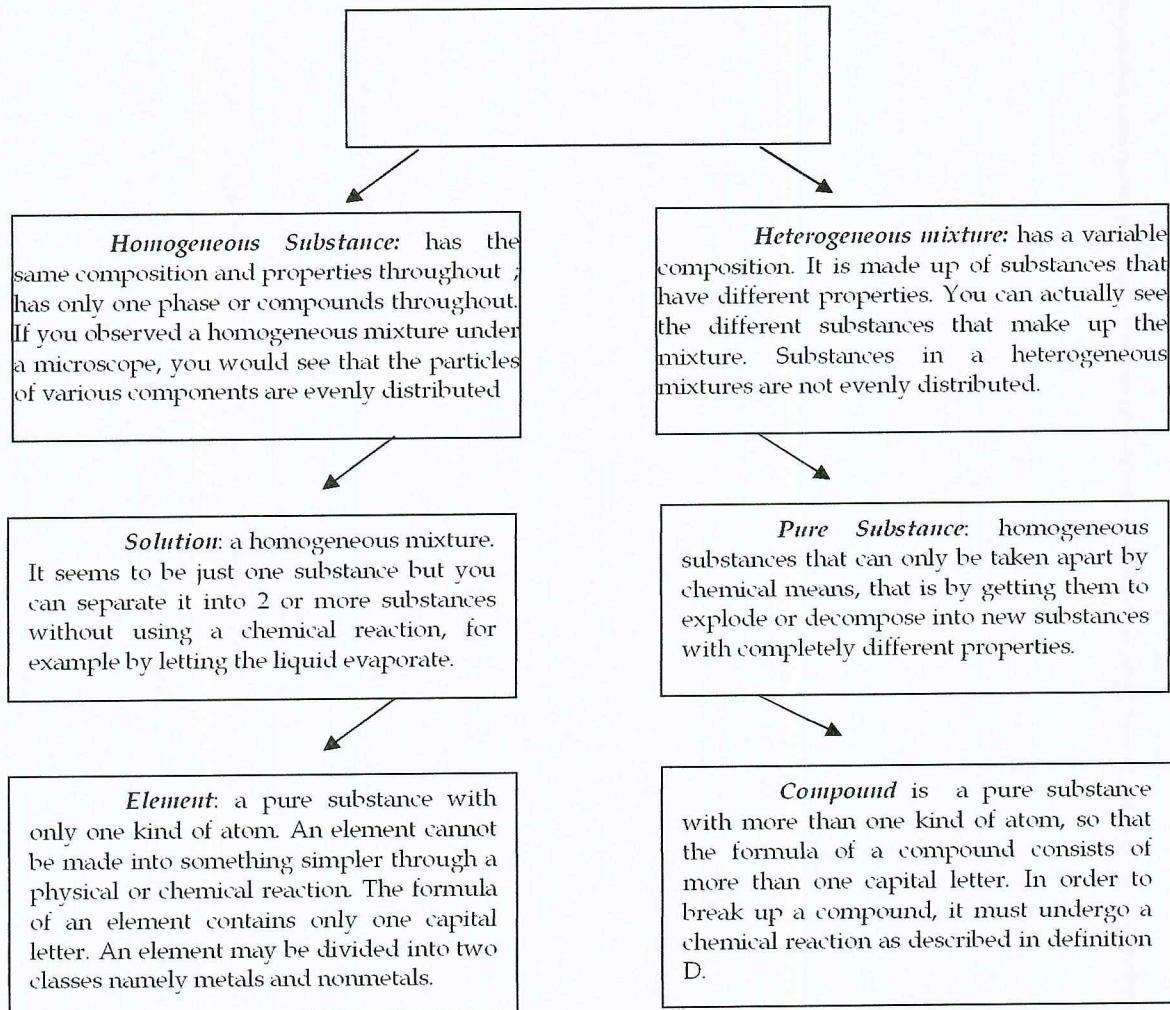
DQ3. brine, coffee with sugar DQ10. grinds

DQ4. banana DQ11. flattens

DQ5. gold, oxygen, sulfur, carbon

DQ6. sulfur dioxide, carbon monoxide

DQ7 Complete the following chart, using definitions A through F.



Answers to Self-test

1. c 8. c

2. a 9. a

3. b 10. b

4. d

5. b

6. c

7. a

FEEDBACK to Answers

You are **Outstanding!** If your score is 10.

Great! If you score 9 or 8.

Just fine! If you score 7 or 6.

If you score 5 and below, **Study more.**

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Calderon, Jose F. *Principles and Practices of Teaching*. Great Books: Quezon City, Philippines, 1998.

Cochran, Leslie H. *Administrative Commitment to Teaching*. Cape Girardeau, Mo.: Step Up, Inc., 1989.

Fraenkel, Jack R. *How to Design and Evaluate Research in Education*. Second Edition. SA: McGraw-Hill, Inc., 1993.

Froebel. *Education Through Self-Activity, Patterns of Educational Philosophy*. New York: World Book Company, 1950.

Gregorio, Herman C. *Principles and Methods of Teaching*. Quezon City: R.P. Garcia Publishing Company, 1976.

Herrin, Alejandro F. *Evaluating Development Projects: Principles and Applications*. Philippines: national Economic Development Council, 1987.

Hyman, Ronald T. *Improving Discussion Leadership*, New York: Columbia University Teachers College Press, 1980.

Labinowicz, Ed. *The Piaget Primer: Thinking, Learning, Teaching*. Menlo Park, CA: Addison-Wesley Publishing Co., 1980.

Lardizbal, Amparo, et al. *Principles and Methods of Teaching*. Quezon City: Phoenix Publishing House Inc., 1991.

Lemlech, JK. *Curriculum and Instructional Methods for the Elementary and Middle School*. New York: McGraw Hill Book Company, Inc., 1979.

Lowman, Joseph. *Mastering the Techniques of Teaching*. San Francisco: Jossey-Bass, 1984.

Mosston, J. and S. Ashworth. *The Spectrum of Teaching Styles*. New York: Longman, 1989.

Ornstein, Allan C. *Strategies for Effective Teaching*. New York: harper College Publishing, 1990.

Penner, Jon G. *Why Many College Teachers Cannot Lecture*. Springfield, Illinnois: Cgarles C. Thomas, 1984.

Random House Unabridged Dictionary, Second Edition. USA: 1993.

Religioso, Teresita. *Science and Progress*. Quezon City: Phoenix Publishing House Inc., 1995.

Sigel, I. and R. Cocking, *Cognitive Development from Childhood to Adolescence: Constructivist Perspective*. NY: Holt, Reinhart and Winston, 1977.

Simon and Feund. *Modern Elementary Statistics*. Eight Edition. USA: Prentice Hall, Inc., 1992.

Walpole, Ronald E. *Introduction to Statistics*. Third Edition. Philippines: Simon and Schuster (Asia) Pte Ltd, 1997.

Webster Third New International Dictionary, USA: Merriam-Webster Inc. Publisher, 1986.

B. JOURNALS/PERIODICALS/PUBLICATION

Amonceda, A. "Modular Instruction." National Institute for Science and Mathematics Education Development. University of the Philippines, Diliman, Quezon City, 2001.

Barr RB and J. Tagg. "From Teaching to Learning A New Paradigm for Undergraduate Education Change." Pp. 13-25, 1995.

Bomwell, C., & J. eison. "Active Learning: Creating Excitement in the Classroom, ASHE-ERIC Higher Education Report No. 1." Washington, DC. George Washington University, 1991.

Bodner, George M. "Why Changing the Curriculum May Not be enough." *Journal of Chemical education*, pp. 186-190, 1992.

Chickering, Arthur W. and Zelda F. Gamson. "Seven Principles for Good Practice. *AAHE Bulletin*, pp. 39: 3-7. ED 282 491. 6 pp. MF-01; PC-01, March 1987.

Ibe, Milagros and Ester Ogena. "Science Education in the Philippines: Overview In Science Education in the Philippines." *Challenges for Development*, Ogena, E., Brawner, F., Eds.; Science Education Institute: Quezon City, pp 7-28, 1998.

Kalem, S. and S. Fer. "The Effects of the Active Learning Model on Students' Learning, Teaching and Communication." *Educational Sciences: Theory & Practice*, 3(2), 455-461, 2003.

Krieger, J. "Chemical Engineering and News." Pp. 27, 1990.

Kuyegkeng, Ma. Assunta C. "Chemistry Beyond the Classroom: Linking High School Chemistry to the Community." *Chemical Education Journal* Volume 5, No. 2, Chemistry Department, Ateneo de Manila University, 2001.

Livingstone, D. and K. Lynch. "Group Project Work and Student-Centered Active Learning: Two Different Experiences." *Journal of Geography in Higher Education*, pp. 26, 217-237, 2002.

McKeachie, Wilbert J., et al. "Teaching and learning in the College Classroom: A Review of the Research Literature." *Ann Arbor: Regents of the University of Michigan*. ED 314 999. 124 pp. MF-01, PC-05, 1986.

Pedersen S. and Liu M. "Teachers' Beliefs About Issues in the Implementation of A Student-Centered Learning Environment. *Educ Techol Res Dev*, 51: 57-76, 2003.

Philippine Commission on Educational Reform. "Philippine Agenda for educational Reform." *The PCER Report*. Manila, 2000.

Ruhl, Kathy L., Charles A. Hughes, and Patrick J. Schloss. "Using the pause Procedure to Enhance Lecture Recall." *Teacher Education and Special Education*, pp. 10, 14-18, 1987.

Singer, D. & T. A. Revenson. "Piaget Primer: How A Child Thinks." NY International Universities Press, Inc., 1978.

Sivan, A., et al. "Towards More Active Learning in Hospitality Studies." *International Journal of Hospitality Management*, pp. 10(4), 369-79, 1991.

Sivan, A., et al. An Implementation of Active Learning and Its Effect on the Quality of Student Learning." *Innovations in Education and Training International*, pp. 37(4), 381-389, 2000.

Talisayon, V. "A Feedback-Based Readability Formula. Monograph 2.' Philippines, 1983.

Talisayon, Vivien M. "Appropriate Physics Curriculum Materials for General education." *Diwang Pisika*, Vol. 1, No. 1.

Tobias, Sheila. "They're Not Dumb. They're Different Stalking the Second Tier." *Research Corporation*, Tucson, Az., pp7, 1990.

Volpe EP. "The Shame of Science Education." *Am Zoologist*, pp. 24, 433-441, 1984.

C. UNPUBLISHED MATERIALS

Arboleras, Rojie C. "Validation of Instructional Materials on Proportion and Variations for Mathematics III." Unpublished Master's Thesis, Samar State Polytechnic College, Catbalogan, Samar, 1999.

Baco, Theresa A. "The Effect of Simulation and Computer-Aided Instruction on the Performance in Trigonometry of Third Year High School Students of Samar State

University." Unpublished Master's Thesis, Samar State University, Catbalogan City, Samar, 2006.

Bacsal, Josephine E. "Effectiveness of Workbook in Mathematics 1." Unpublished Master's Thesis, Samar State Polytechnic College, Catbalogan, Samar.

Calapre, Imelda P. "The Effect of Modular Instruction of the Achievement in Rational Number of Grade Six Pupils." Unpublished Master's Thesis, Leyte State College, Tacloban City.

Ellado, Geronimo A. "Validation of Developed Instructional Materials in High School Chemistry." Unpublished Master's Thesis, Samar State Polytechnic College, Catbalogan, Samar, 1998.

Figuerres, O. "Development and Validation of learning Packages in Automotive Technology III." Unpublished Doctoral Dissertation, De La Salle University, 1994.

Irene, Elmer A. "Computer-Assisted Instruction in Chemistry for Secondary Students: Its Implications for Instructional Redirections." Unpublished Master's Thesis, Samar State University, Catbalogan City, Samar.

Karamustafaoglu, S. "Developing Guide Material-Based on Simple Tools Related to the Unit Travel to the Inner Structure of Matter and Its effectiveness on Teaching Process." Unpublished Doctoral Dissertation, KTU, Trabzon, 2003.

Maniable, Modesto M. "The Development and Evaluation of Instructional Modules in Electricity for High School Students." Unpublished Master's Thesis, Leyte Normal University, Tacloban City, 2003.

Padilla, Pedrito G. "Students' Achievement in Science and Technology in secondary Education Development Program (SEDP): The Eastern Visayas Experience." Unpublished Doctoral Dissertation, Samar State University, Catbalogan City, 2006.

Pahila, Florentina C. "Differential effectiveness of the Modular Approach in the Teaching of Integrated Science." Unpublished Master's Thesis, De La Salle University, Manila, 1994.

Pino, Antonio A. "Practical Arts Performance of Senior High School Students in Samar: Basis for Instructional Redirection." Unpublished Master's Thesis, Samar State Polytechnic College, Catbalogan, Samar, 1992.

Sumugat, Surlita. "The Effects of OTT's Taxonomy Based Module in Chemistry." Unpublished Doctoral Dissertation, GIMMIN-ADDU, UM, Davao City, 1996.

Tacardon, Anita B. "The Effectiveness of Activity Based in Teaching College Algebra." Unpublished Doctoral Dissertation, GIMMIN-ADDU, UM, Davao City, 1996.

Velasco, Rosario R. "Modular Approach Versus Conventional Approach in Teaching Chemistry to the Third Year Students at Kisante High School, Cotabato

Province." Unpublished Doctoral Dissertation, University of Southern Mindanao, Kabacan, North Cotabato, 2002.

Yecyec, Romana B. "Comparative Study of Active Learning Strategies and Expository Method in Teaching Natural Science." Unpublished Master's Thesis, Kidapawan City, 1998.

D. ELECTRONIC AND OTHER SOURCES

Akinoglu, Orhan and Tandogan, Ruhan Ozkardes. The Effects of Problem-based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning, 2006 [Online]. Available: <http://www.ejmste.com>

Blair, Kristine. Use Active Learning Techniques, 2006 [Online]. Available: <http://www.oln.org/ILT/blair.php>

Dictionary of Psychology, Oxford University Press. 2001 [Online]. Available: <http://www.en.wikipedia.org/wiki/word.html>

Johnson DW, Johnson RT, and Stanne MB. Cooperative Learning Methods: a Meta-analysis. 2006 [Online]. Available: <http://www.co-operation.org/pages/cl-methods.html>

Karamustafaoglu, O., Sevilay, S. Karamustafaoglu S. Teaching Methods Used by Science Teachers: The case for Trabzon. X National Education Conference, 7-9 June, 2001, Abant Izzet Baysal University, Bolu, Turkey, 2001 [Online]. Available: <http://www.ied.edu.hk/apfslt/v7issue1/costu/costu8.htm#eight>

McKay, Dawn Rosenberg. Interest Inventory. (undated0. [Online]. Available: <http://www.careerplanning.about.com/mbiopage/htm>

Michael, Joel. Where's the evidence that active learning works? Advances in Physiology Education 30, 159-167, 2006 [Online]. Available: [http://www.where'stheevidencethatactivelearningworks-Michael30\(4\)159--AdvancesinPhysiologyEducation.htm](http://www.where'stheevidencethatactivelearningworks-Michael30(4)159--AdvancesinPhysiologyEducation.htm)

Mahajan, D. S and Singh, G.S. University Students' Performance in Organic Chemistry at Undergraduate Level: Perception of Instructors from Universities in the SADC Region. Department of Chemistry, University of Botswana, 2004. [Online]. Available: <http://www.dmahajan@temo.bca.bw>

Sevilay, Karamustafaoglu. Turkish Chemistry Teachers' Views about an Implementation of the Active Learning Approaches in Their Lessons: Asia-Pacific Forum on Science Learning and Teaching, 2006 [Online]. Available: <http://www.sevilayt2000@yahoo.com>

A P P E N D I C E S

APPENDIX A

Letter for Approval of the Problem

Republic of the Philippines
SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

August 23, 2004

MARILYN D CARDOSO, Ph. D.
Dean, Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar

Madam:

In my desire to start writing my thesis proposal, I have the honor to submit one the following research problems, preferable number 1:

1. Development and Validation of Materials For Active Learning Approach in Teaching Chemistry 101.
2. Effectiveness of Computer-Aided Instruction in Teaching Chemistry 101.
3. An Improvised Oscilloscope: A Technical Study

I hope for your early and favorable action on this matter.

Very truly yours,

(Sgd.) VIVIAN B. LUCABAN
Researcher

APPROVED:

(Sgd.) MARILYN D. CARDOSO, Ph.D.
Dean, College of Graduate Studies

APPENDIX B

Assignment of Adviser

Republic of the Philippines
SAMAR STATE POLYTECHNIC COLLEGE
COLLEGE OF GRADUATE STUDIES
Catbalogan, Samar

October 09, 2004

DR. ESTEBAN A. MALINDOG, JR.
This University

Dear Sir:

Please be informed that you have been designated as adviser of Ms. Vivian B. Lucaban candidate for the degree in Master of Arts in Teaching major in Chemistry who proposes to write a thesis entitled "DEVELOPMENT AND VALIDATION OF MATERIAL FOR ACTIVE LEARNING APPROACH IN TEACHING CHEMISTRY 101."

Thank you for your cooperation.

Very truly yours,

MARILYN D. CARDOSO, Ph. D.
Dean, College of Graduate Studies

CONFORME:

ESTEBAN A. MALINDOG, JR., Ph. D.
Adviser

1st copy - Dean's Office
2nd copy - Adviser
3rd copy - Researcher

APPENDIX C

Request for Pre-Oral Defense

Republic of the Philippines
SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

June 14, 2005

MARILYN D. CARDOSO, Ph.D.
Dean, Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar

Madam:

This thesis proposal entitled "DEVELOPMENT AND VALIDATION OF MATERIAL FOR ACTIVE LEARNING APPROACH IN CHEMISTRY 101" prepared and submitted by Ms. Vivian B. Lucaban in partial fulfillment of the requirements for the degree MAT-Chemistry is recommended for Pre-Oral Examination on the date and time convenient to your office.

(Sgd.) ESTEBAN A. MALINDOG JR, Ph.D.
Adviser

Date of ORAL DEFENSE	
June 26, 2005	
Sunday	Day
1:30 PM	Time

SSU GRADUATE SCHOOL
Dean's Office

APPENDIX D

**Request Permission to Conduct an Interest Inventory
and Administer Pretest/Posttest Try-out**

Republic of the Philippines
SAMAR STATE UNIVERSITY
Catbalogan, Samar

July 06, 2006

Sir:

This is in connection with my thesis entitled "Development and Validation of Material For Active Learning Approach in Teaching Chemistry 101". The undersigned would like to seek approval to conduct an Interest Inventory and Pretest/Posttest to second year students of BS Information Management BS Information Technology and BS Information Technology.

Your kind and favorable consideration and preferential attention to this request would be highly appreciated.

Very truly yours,

(Sgd.) VIVIAN B. LUCABAN
Researcher

NOTED:

(Sgd.) ESTEBAN A. MALINDOG JR. Ph. D.
Adviser

APPROVED:

(Sgd.) MELDRITO B. VALLES, Ph.D.
Dean, College of Arts & Sciences

APPENDIX E
TABLE OF SPECIFICATIONS

Topic	Number of Items (Item No.)					
	K	C	Ap	An	Total	%
1. Observation of Matter	1 (10)	1 (14)	3 (4,7,26)		5	16.7
2. Measurement of Matter	1 (16)	2 (3,12)		2 (21,28)	5	16.7
3. States of Matter	1 (23)	2 (13,30)	2 (5,24)		5	16.7
4. Properties of Matter	2 (6,18)	3 (1,8,20)			5	16.7
5. Changes of Matter	2 (22,25)	1 (29)	1 (11)		4	13.3
6. Classification of Matter	2 (17,27)	1 (9)	3 (2,15,19)		6	20
Total	9	10	9	2	30	100

APPENDIX F

Pretest/Posttest

Name: _____ Date: _____
Year and Course: _____ Score: _____

Direction: Read each item carefully. Select the best answer from the given choices. Write your answer on the space provided before each number.

- ____ 1. Which of the following statements does NOT describe the property of a pure substance?
 - a. contains the same ratio of elements always
 - b. may have different properties depending on the source
 - c. has a definite melting point
 - d. has a definite boiling point

- ____ 2. Which of the following symbols is not correctly associated with its element?

a. Beryllium ; Be	c. Oxygen; O
b. Nitrogen ; Ni	d. Aluminum; Al

- ____ 3. If a measurement was precise, but not accurate, it was:
 - a. Repeatable, but not close to the true value
 - b. Close to the true value, but not repeatable
 - c. Repeatable, and close to the true value
 - d. Not repeatable, and not close to the true value

- ____ 4. Which step of the Scientific Method is happening here

The sugar cube dissolved at a water temperature of 23.8°C (75°F) in 36 seconds.

- a. recording and analyzing data
- b. replication and formatting new questions
- c. making observation
- d. forming a conclusion

____ 5. Which statement is NOT true?

- to change from a solid to a liquid requires energy
- depending upon the temperature, water can exist in solid, liquid or gas states
- solids and liquids have similar densities because particles of solids and liquids both touch
- in a solid the molecules have no motion and no energy

____ 6. The following are examples of physical properties except ONE:

a. changes of state	c. hardness
b. density	d. production of gas bubbles

____ 7. A student investigated the physical and chemical properties of a sample of unknown gas and then investigated the gas. Which statement represents a conclusion rather than an experimental observation?

- The gas is colorless.
- The gas is carbon dioxide.
- When the gas is bubbled in limewater, the liquid becomes cloudy
- When placed in the gas, a flaming splint stops burning

____ 8. Which statement describes a chemical property?

- Its crystals are a metallic gray.
- It dissolves in alcohol.
- It forms a violet-colored gas.
- It reacts with hydrogen to form a gas.

____ 9. A compound differs from a mixture in that a compound always has

- homogeneous composition
- maximum of two components
- minimum of three components
- heterogeneous composition

____ 10. A hypothesis is

- a description of a pattern or relationship in experimental data
- obeyed under any circumstances
- a theory that has been proved
- a tentative explanation for a natural phenomenon

11. A solid has _____.

- maximum intermolecular space
- definite mass but no definite volume
- very high compressibility
- maximum intermolecular force of attraction

12. Which of the following is not a correct prefix and corresponding multiple?

a. kilo, 10^3	c. milli, 10^{-3}
b. deci, 10^{-1}	d. nano, 10^{-6}

13. The process of a solid changing into liquid is called _____.

a. liquefaction	c. boiling
b. melting	d. freezing

14. The first step of the scientific method involves:

a. forming hypothesis	c. performing an experiment
b. making observations	d. making conclusion

15. The following are examples of a heterogeneous mixture except ONE:

a. fruit salad	c. spaghetti
b. Quaker oats	d. coffee with sugar

16. Which of the following is the correct decimal power that corresponds to the prefix μ ?

a. 10^{-2}	c. 10^{-3}
b. 10^{-6}	d. 10^{-9}

17. Particles scatter light and are easily distinguished (Tyndall effect) is a characteristic of

a. an element	c. a colloid
b. a solution	d. a pure substance

18. Which of the following is an intensive property?

a. mass	c. volume of a liquid
b. temperature	d. heat content

_____ 26. Symptoms include nausea or dizziness
a. Bacteria in the oysters may have caused the illness.
b. Everyone who eat the oyster got sick.

_____ 27. The name for the element with chemical symbol S is
a. silicon
b. silver
c. sodium
d. sulfur

_____ 28. The Voyager 1 flyby of Saturn revealed that the surface temperature of the moon Titan is 93 K. What is the surface temperature in degree Celsius?
a. -292°C
b. 6°C
c. -180°C
d. 14°C

_____ 29. The temperature at which a solid will change to a liquid is _____.
a. freezing point
b. melting point
c. liquefaction point
d. boiling point

_____ 30. Conversion of gas to liquid is called _____.
a. condensation
b. sublimation
c. vaporization
d. solidification

APPENDIX G

**Facility Value (FV) and Discrimination
Index (ID) of the Test Instrument**

Item No.	FV	Interpretation	ID	Interpretation
1	0.36	Medium Difficult	0.40	High
2	0.88	Medium Easy	0.40	High
3	0.56	Medium Difficult	0.25	Marginal
4	0.50	Medium Difficult	0.30	Well
5	0.29	Very Difficult	0.20	Marginal
6	0.69	Medium Difficult	0.45	High
7	0.21	Very Difficult	0.45	High
8	0.60	Medium Difficult	0.30	Well
9	0.61	Medium Difficult	0.35	Well
10	0.30	Medium Difficult	0.30	Well
11	0.52	Medium Difficult	0.40	High
12	0.65	Medium Difficult	0.25	Marginal
13	0.81	Medium Easy	0.25	Marginal
14	0.88	Medium Easy	0.30	Well
15	0.55	Medium Difficult	0.35	Well
16	0.38	Medium Difficult	0.40	High
17	0.32	Medium Difficult	0.55	High
18	0.70	Medium Difficult	0.30	Well
19	0.45	Medium Difficult	0.40	High
20	0.47	Medium Difficult	0.25	Marginal
21	0.22	Very Difficult	0.30	Well
22	0.44	Medium Difficult	0.25	Marginal
23	0.73	Medium Easy	0.25	Marginal
24	0.65	Medium Difficult	0.30	Well
25	0.47	Medium Difficult	0.35	Well
26	0.18	Very Difficult	0.20	Marginal
27	0.55	Medium Difficult	0.30	Well
28	0.27	Very Difficult	0.30	Well
29	0.35	Medium Difficult	0.45	High
30	0.43	Medium Difficult	0.20	Marginal
Mean	0.50	-	0.33	-
Kuder-Richardson			21	-
Reliability Coefficient			0.73	-

APPENDIX H
Request to Conduct Experimentation at College of Arts & Sciences

Republic of the Philippines
SAMAR STATE UNIVERSITY
Catbalogan, Samar

June 2, 2008

SIMON P. BABALCON JR., Ph. D.
University President

Thru Channel

Sir:

This is in my connection with my thesis entitled "Development and Validation of Material For Active Learning Approach in Teaching Chemistry 101". The undersigned would like to seek approval to conduct her experimentation in the College of Arts & Sciences Department considering that the experiment will be using its chemistry laboratory and BS Info Tech as its respondents.

Further the experimenter would like to ask permission to be excused from her classes in Basey Campus for the duration of the experiment with tentative schedule of June 10-20, 2008.

Attached herewith is the proposed schedule of the conduct of the experiment.
Thank you and more power.

Very truly yours,

(Sgd.) VIVIAN L. MOYA
Researcher

NOTED:

(Sgd.) MARILYN D. CARDOSO, Ph.D.
Dean, College of Graduate Studies

RECOMMENDING APPROVAL:

(Sgd.) MELDRITO B. VALLES
Dean, College of Arts & Sciences

(Sgd.) EUSEBIO T. PACOLOR, Ph.D.
Vice President for Academic Affairs

APPROVED:

(Sgd.)SIMON P. BABALCON, Ph.D.
University President

APPENDIX I

SCHEDULE OF THE CONDUCT OF THE EXPERIMENTATION @ MICROBIOLOGY LAB

Experimental Group

Date	Time	Topic
June 10, 2008	9:00-11:00 AM	Introduction Module 1 -Observation of Matter
June 18, 2008	9:00-11:00 AM	Module 2- Measurement of Matter
June 23, 2008	9:00-11:00 AM	Module 3- States of Matter Module 4 – Properties of Matter
June 27, 2008	9:00-11:00 AM	Module 5 – Changes of Matter Module 6 – Classification of Matter

Control Group

Date	Time	Topic
June 14, 2008	2:00-5:00 PM	Introduction Lesson 1 -Observation of Matter Lesson 2 -Measurement of Matter
June 17, 2008	4:00-5:00 PM	Continuation of Lesson 2
June 19, 2008	4:00-5:00 PM	Lesson 3 - States of Matter Lesson 4- Properties of Matter
June 21, 2008	4:00-5:00 AM	Lesson 5 – Changes of Matter Lesson 6 – Classification of Matter

APPENDIX J

Composition of the Experimental Group Based On Age, Sex, Scholastic Performance in High School and Socio-Economic Status

BS Info Tech 1A	Sex	Age	Grade	Income
1	F	16	85.56	8,500.00
2	M	16	83.33	9,000.00
3	F	16.5	83.24	8,500.00
4	F	16	82.54	5,300.00
5	F	16.5	88.10	4,500.00
6	M	16	87.15	6,800.00
7	M	17	90.02	39,000.00
8	M	17.5	85.11	10,800.00
9	M	15.5	86.10	5,000.00
10	F	16	85.24	8,500.00
11	M	17.5	85.14	8,000.00
12	F	17	82.90	15,200.00
13	M	16	86.38	10,500.00
14	F	16.5	83.82	16,000.00
15	F	16.5	86.32	8,000.00
16	F	16	88.96	9,500.00
17	F	16	85.00	9,500.00
18	F	17.5	85.25	20,800.00
19	M	16	83.24	18,500.00
20	F	17	82.91	12,000.00
21	F	17.5	86.38	5,500.00
22	F	15.5	82.91	8,000.00
23	F	16.5	89.09	10,000.00
24	M	17	82.12	9,500.00
25	F	17	83.01	18,000.00
26	F	15.5	90.99	7,500.00
27	F	16	86.56	5,000.00
28	F	17	84.23	15,500.00
29	M	16	82.00	10,000.00
30	F	17	83.82	9,500.00
TOTAL	M=10	494	2557.42	356,380.00
AVERAGE	F=20	16.47	85.25	11,879.33

APPENDIX K

**Composition of the Control Group Based On Age, Sex, Scholastic Performance
in High School and Socio-Economic Status**

BS Info Tech 1A	Sex	Age	Grade	Income
1	F	16 1/2	79.81	24,400.00
2	F	17 1/2	85.65	15,000.00
3	F	16 1/2	87.02	12,000.00
4	F	16 1/2	86.20	6,000.00
5	F	16 1/2	85.90	95,800.00
6	F	16	85.15	5,800.00
7	M	17	83.05	8,800.00
8	F	15 1/2	84.04	5,500.00
9	F	17 1/2	86.26	8,000.00
10	M	16 1/2	82.56	28,200.00
11	F	16 1/2	83.50	6,500.00
12	F	16	87.10	5,000.00
13	F	15 1/2	88.70	10,000.00
14	F	17	84.35	8,000.00
15	M	16	84.01	29,500.00
16	F	15 1/2	85.35	6,500.00
17	M	16	82.45	8,800.00
18	F	17	85.31	7,200.00
19	M	16	84.41	32,000.00
20	M	17 1/2	85.20	6,500.00
21	F	16 1/2	86.03	16,500.00
22	M	16 1/2	83.30	10,000.00
23	M	16	83.75	5,000.00
24	F	17 1/2	81.36	15,800.00
25	F	16	84.04	8,500.00
26	M	17	83.01	8,500.00
27	F	16	82.78	7,500.00
28	F	16	88.40	5,500.00
29	M	16	81.25	12,000.00
30	F	16	89.56	5,000.00
TOTAL	M=20	492.50	2540.50	337,500.00
AVERAGE	F=10	16.42	84.68	11,250.00

APPENDIX L

Questionnaire for Student's Level of Interest in Chemistry

Name of Respondent: _____ Date: _____
 Year & Course: _____ Age: _____
 Gender: _____

Direction: Carefully read each statement below and kindly check on the space provided your honest feeling about each statement as:

5	Strongly Agree (SA)	2	Disagree (D)
4	Agree (A)	1	Strongly Disagree (SD)
3	Uncertain (U)		

Indicators	5	4	3	2	1
1. I am interested in knowing how chemistry develops and its importance to our daily life.					
2. I can relate the scientific method in solving my problems and do activities related to it.					
3. I can easily classify matter into elements, compounds and mixtures.					
4. I love memorizing the symbols of elements and chemical formulas of compounds.					
5. I find it easy to differentiate between physical and chemical properties and changes in matter.					
6. I am interested in knowing how atoms, molecules and ions differ from each other.					
7. I find it interesting and enjoyable in identifying the atomic number and mass number of subatomic particles.					
8. I am interested in how the number of orbital					

and the maximum number of electrons related to each other.					
9. I find Hund's Rule, spin quantum number and Pauli Exclusion Principle interesting and meaningful.					
10. I am interested on how the periodic table is set up.					
11. I find it easy to classify elements into representative elements, noble gases, transition metals and inner transition metals using the periodic table of elements.					
12. I am interested on how elements are divided into periods, groups and families.					
13. I find it interesting to predict periodic variations in metallic properties, atomic size, ionic size, ionization energy, electron affinity and electronegativity using the periodic table of elements.					
14. I like writing the correct names and formulas of binary compounds, bases, oxyacids and salts.					
15. I am interested on how ionic bond and covalent bond are formed.					
16. I like the topics in chemical bonding because they are interesting and easy.					
17. I can relate to the bonding concept to the company of my friends and classmates.					
18. I enjoy drawing Lewis structures for molecules and its resonance forms.					
19. I find it easy to predict molecular geometry in terms of VSEPR theory.					

20. I find balancing chemical equation enjoyable.					
21. I appreciate the significance of knowing how to read and write formulas when working in the laboratory.					
22. I find the lesson in thermochemistry enjoyable and interesting.					
23. I enjoy doing stoichiometric calculations involving heat transfer from thermochemical equations.					
24. I like the topic on enthalpy, entropy, and its relation to total energy change.					
25. I find it interesting on how calorimeter works.					
26. I like to discuss the principles of First and Second Law of Thermodynamics.					
27. I like doing calculations involving relationships between volume and pressure, volume and temperature and temperature and pressure.					
28. I enjoy doing experiments about Kinetic Molecular Theory as applied to gases.					
29. I love to do experiments related to solid, liquid and gas.					
30. I am interested on how solutions differ from a colloid.					

APPENDIX M

Scores of the Control Group in the Pretest and Posttest

Student Number	Scores		Difference
	Pretest	Posttest	
1	15	16	1
2	13	18	5
3	11	20	9
4	14	18	4
5	15	17	2
6	14	20	6
7	13	21	8
8	13	20	7
9	9	21	12
10	13	15	2
11	17	16	-1
12	15	16	1
13	15	16	1
14	11	18	7
15	13	14	1
16	20	17	-3
17	18	24	6
18	12	11	-1
19	13	18	5
20	16	18	2
21	11	17	6
22	10	19	9
23	16	16	0
24	16	14	-2
25	13	17	4
26	9	16	7
27	13	24	11
28	14	16	2
29	12	20	8
30	8	15	7
Total	402	528	126
Mean	13.40	17.60	4.20
Variance	7.28	8.04	15.41

APPENDIX N

Computer-Based Statistical Analysis of the Pretest and Posttest Scores of the Control Group

	<i>Variable 1</i>	<i>Variable 2</i>
Mean	13.4	17.6
Variance	7.282758621	8.04137931
Observations	30	30
Pearson Correlation	-0.00540717	
Hypothesized Mean Difference	0	
Df	29	
t Stat	-5.860738371	
P(T<=t) one-tail	1.16773E-06	
t Critical one-tail	1.699126996	
P(T<=t) two-tail	2.33547E-06	
t Critical two-tail	2.045229611	

Interpretation: Reject H_0

APPENDIX O

Scores of the Experimental Group in the Pretest and Posttest

Student Number	Scores		Difference
	Pretest	Posttest	
1	14	19	5
2	9	16	7
3	11	15	4
4	16	19	3
5	17	21	4
6	9	26	17
7	14	18	4
8	14	12	-2
9	16	20	4
10	16	19	3
11	7	15	8
12	13	20	7
13	8	12	4
14	15	20	5
15	10	19	9
16	11	21	10
17	12	21	9
18	12	19	7
19	16	16	0
20	16	22	6
21	14	26	12
22	14	14	0
23	13	22	9
24	10	15	5
25	10	19	9
26	19	23	4
27	10	19	9
28	21	21	0
29	9	15	6
30	16	19	3
Total	392	563	171
Mean	13.07	18.77	5.70
Variance	11.51	12.25	15.46

APPENDIX P

Comparison of the Posttest Scores of the EG & CG

Student Number	Experimental Group	Control Group
1	19	16
2	16	18
3	15	20
4	19	18
5	21	17
6	26	20
7	18	21
8	12	20
9	20	21
10	19	15
11	15	16
12	20	16
13	12	16
14	20	18
15	19	14
16	21	17
17	21	24
18	19	11
19	16	18
20	22	18
21	26	17
22	14	19
23	22	16
24	15	14
25	19	17
26	23	16
27	19	24
28	21	16
29	15	20
30	19	15
Total	563	528
Mean	18.77	17.60
Variance	12.25	8.04

t-Test Two Sample Assuming Unequal Variances

	<i>Variable 1</i>	<i>Variable 2</i>
Mean	18.76666667	17.6
Variance	12.25402299	8.04137931
Observations	30	30
Hypothesized Mean Difference	0	
Df	56	
t Stat	1.41843221	
P(T<=t) one-tail	0.08080302	
t Critical one-tail	1.672522304	
P(T<=t) two-tail	0.161606039	
t Critical two-tail	2.003240704	

Interpretation: Accept H_0

APPENDIX Q

Computer-Based Statistical Analysis of the Pretest and Posttest Scores of the Experimental Group

	Variable 1	Variable 2
Mean	13.06666667	18.76666667
Variance	11.51264368	12.25402299
Observations	30	30
Pearson Correlation	0.349737353	
Hypothesized Mean Difference	0	
Df	29	
t Stat	-7.940541366	
P(T<=t) one-tail	4.65774E-09	
t Critical one-tail	1.699126996	
P(T<=t) two-tail	9.31549E-09	
t Critical two-tail	2.045229611	

Interpretation: Reject H_0

C U R R I C U L U M V I T A E

CURRICULUM VITAE

Name: VIVIAN LUCABAN MOYA
Address: #1018, P.7, BRGY. MERCEDES, CATBALOGAN CITY,
SAMAR
Date of Birth: OCTOBER 12, 1978
Place of Birth: MSU COMPOUND, MARAWI CITY, LANAO DEL SUR
Civil Status: Married
Spouse' Name: ILT SANTIAGO PILLORA MOYA
Child's Name: VIN MICHELLE L. MOYA
Father: VIVENCIO C. LUCABAN
Mother: LIGAYA B. LUCABAN
Sisters: LIBERTY, VENICE & VENUS

EDUCATIONAL BACKGROUND

Elementary: Camp Evangelista Elementary School, Cagayan de Oro City
1985-1991
Secondary: Cagayan de Oro College, Cagayan de Oro City
1991-1992
Agusan National High School, Butuan City
1992-1995
Tertiary: Samar State Polytechnic College, Catbalogan, Samar
1995-1991

Graduate Studies: Samar State Polytechnic College, Catbalogan, Samar
2005-2008

Degree: Master of Arts in Teaching
Major: Chemistry

AWARDS AND RECOGNITION

Elementary: Class Honors, Grade I to Grade VI
Secondary: Class Honors, First Year to Fourth Year
Tertiary: Dean's Lister, First Year to Fourth Year
CUM LAUDE, Fourth Year

SEMINARS/TRAININGS ATTENDED

Alliance For the Promotion of Science and Technology Advantages For the People, March 11, 2005, UP M&T Hall, Tacloban City

Seminar-Workshop on Verbalizing and Conceptualizing Research Project, February 4-5, 2008, Multi Purpose Room, College of Graduate Studies, Catbalogan City, Samar

Seminar-Workshop on Gender Sensitivity and Gender Responsive Planning, February 14-15, 2008, Mabuhay Conference Room, Mabuhay Conference Room, Catbalogan City, Samar

ELIGIBILITY

Civil Service Commission Eligibility for Honor Graduate PD #901
March 19, 1999

Licensure Examination for Teachers, Tacloban City,
August, 1999

LIST OF TABLES

Table		Page
1	Age Distribution of the Subjects	60
2	Sex Distribution of the Subjects	61
3	Scholastic Performance in High School of the Subjects	62
4	Average Family Income of the Subjects	64
5	Level of Interest of the Subjects in Chemistry 101	66
6	Readability Level of the Module	68
7	Pretest Scores of the Experimental and Control Groups	70
8	Pretest and Posttest Scores of the Control Group	72
9	Pretest and Posttest Scores of the Experimental Group	74
10	Posttest Scores of the Experimental and Control Group	76
11	Evaluation of the Module by the Experimental Group	77

LIST OF FIGURE

Figure	Page
1 Conceptual Framework of the Study	9