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ABSTRACT

This study was conducted to identify and determine the level of misconceptions in General Inorganic Chemistry on basic physical concepts and matter and chemical reactions among engineering students of the University of Baguio and determine if there are significant relationships in the students' level of misconception as affected by attitude toward chemistry, academic performance, and students' background such as high school grade in chemistry, ethnic background, and parent's educational background.

Findings have shown that the students' level of misconception in General Inorganic Chemistry is high. Moreover, it was found out that the level of attitude of the students towards chemistry ranged from poor to fair; the students' level of academic performance is poor, and most of the students' high school grade in chemistry is fair. It was also found out that majority of the students are non-Cordillerans and most of the respondents have parents with at least one parent reaching tertiary education.

Statistical analyses have shown that students are more misconcepted on basic physical concepts and matter than on chemical reactions. From regression analysis, it was found out that attitude towards chemistry and academic performance has significant effects on the students' level of misconception. However, students' background which includes students' high school grade in chemistry, ethnic background, and parent's educational attainment have insignificant relationships on the students' level of misconception.

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INTRODUCTION

Of all the sciences, chemistry is probably the one which has the closest links with all the others. Chemistry not only provides the basis for much of what goes on in our world but it is a vital, continually growing science. It is an extremely practical science and has been very influential in its impact on our daily living, health care, conservation of natural resources, protection of the environment, and provision of our everyday needs for food, clothing, and shelter. It is also probably the one which is the most difficult to divide into tidy watertight compartments. The result is that, although the ordinary citizen might like or need to know about chemistry, it is very difficult for him or her to get started. Chemistry education is an important factor for global competitiveness. Learning chemistry requires both the assimilation of many new concepts and the development of analytical skills.

Many students view chemistry as one of the most difficult subjects to study in all levels of schooling. Students at all ages hold a wide variety of scientifically faulty knowledge structures called “misconceptions” (Arizona State University, 2001). As far as misconceptions in chemistry are concerned, college students are no exception. Learning chemistry places many demands on students and teachers that seem insurmountable. Instructors display mathematical formulas, chemical symbols, and scientific measurements simultaneously to describe phenomena that are not readily apparent to students. Moreover, the

concepts of chemistry are often seen as abstractions confined to the classroom and not applicable outside of school. These perceived difficulties are part of the context in which these students develop chemical concepts and problem-solving skills.

To deal with such difficulties, chemistry educators have devoted considerable time to developing curricula that help students visualize the molecular world and connect classroom concepts to observable phenomena. Hence, a specialized science subject such as chemistry should be taught by competent teachers.

Background of the Study

Most students cannot grasp the full depth and detail of any chemical concept the first time that it is presented to them. It has been found that most people learn effectively by first being given a basic description of the concepts then developing their detailed understanding over time. Despite the best efforts of educators, a few misconceptions are at times introduced by attempting to avoid a detailed description in introductory courses (Novak, 1999).

Over the past years, there have been many studies of students' understandings and misunderstandings with regards to science, in general, and to chemistry, in particular. Many of these studies have found that students hold concepts which are different than those accepted as correct by the scientific experts. These alternative views have been given several names such as

"alternative frameworks", "children's science", and "misconceptions" (Chemistry Education Research, 2005).

In the constructivist theory of learning, the learner's role is taken to be an active role, not a passive role. Learners base their understanding on their previous knowledge. It is the knowledge and experiences that students bring with them that have the greatest influence in their learning. Therefore, an understanding of the concepts students hold prior to instruction is of paramount importance for effective instruction.

The difficulty with science education is that so much of it is actually reeducation. It was observed that when educators teach something about which the students have never heard, the students generally both welcome and understand the topic. But when they have to teach something which they have already learned incorrectly, that is when the educators start to identify with Sisyphus (Fraser, 1996). Although vernacular and factual misconceptions can often be easily corrected, even by the students themselves, it is not effective for a teacher simply to insist that the learner dismiss preconceived notions and ingrained nonscientific beliefs. Recent researches on students' conceptual misunderstandings of natural phenomenon indicate that new concepts cannot be learned if alternative models that explain a phenomenon already exist in the learner's mind. Although scientists commonly view such erroneous models with disdain, they are often preferred by the learner because they seem more

reasonable and perhaps are more useful for the learner's purpose (Mayer, 1987 as cited by Nap, 2000). These beliefs can persist in a student's mind and can hinder further learning (McDermott, 1991 as cited by Nap, 2000).

Statement of the Problem

The major purpose of this study was to identify and determine the level of misconceptions on general theories in General Inorganic Chemistry, and its correlation to attitude and academic performance among engineering students of the University of Baguio.

Specifically, answers to the following questions were determined:

1. What are the misconceptions in General Inorganic Chemistry on basic physical concepts and matter and chemical reactions among engineering students of the University of Baguio?

2. What is the level of attitude of engineering students towards chemistry?

3. What is the students' level of academic performance in General Inorganic Chemistry?

4. What is the extent of relationship in the students' levels of misconceptions considering student's background such as high school grade in chemistry, ethnic background, and parent's educational attainment, attitude toward chemistry, and academic performance?

Objectives of the Study

The objectives of this study were as follows:

1. To identify and determine the level of misconceptions in General Inorganic Chemistry on basic physical concepts and matter and chemical reactions among engineering students of the University of Baguio.

2. To determine the students' level of attitude towards chemistry.

3. To determine the students' level of academic performance in General Inorganic Chemistry.

4. To determine the relationship between students' level of misconception in General Inorganic Chemistry and the variables attitude towards chemistry, academic performance in General Inorganic Chemistry, and student's background such as high school grade in chemistry, ethnic background, and parent's educational background.

Importance of the Study

The researcher finds that the present study is important on the following grounds:

1. Identifying key misconceptions could help in redesigning the course to enable the students to have a better understanding of familiar concepts.

2. The world of misconceptions is a window into how students actually think. Teachers could gain a sound understanding of how students think.

3. Clarification of common misconceptions could improve academic performance of students.

4. Awareness of these misconceptions will help the students formulate better ideas or new concepts.

5. Knowing the causes, and consequently, corrections of these misconceptions could improve the students' attitude towards the subject.

6. Determining the students' attitude towards chemistry would enable chemistry teachers to improve their teaching methodology.

Scope and Delimitation of the Study

This study aimed to determine misconceptions in General Inorganic Chemistry on basic physical concepts and matter and chemical reactions. The selection of topics were based from the course syllabus ENGCHM 1 used by the University Of Baguio College Of Engineering during the First Semester School Year 2005 – 2006. Appendix A shows the course syllabus for ENGCHM 1.

The intervening factors which were investigated in this study included the following demographic data; high school rating in chemistry, ethnic background, parents' educational attainment, attitude towards chemistry, and academic performance. Gender was not included since the respondents were all male, given that engineering is a course dominated by male.

The actual number of respondents who participated in this study was predicted to diminish as compared to the actual number of enrollees indicated in

the official student list by the Engineering Dean's Office. This was due to the number of students who dropped or withdrew the subject in the succeeding months. Other reasons for the exclusion of a respondent include insufficient data from the registrar's office records, transferee student with incomplete transfer credentials, and a new student who has not submitted any credentials to the registrar's office.

REVIEW OF LITERATURE

On Misconceptions

In science, there are often many concepts that are frequently misinterpreted. This may be the result of students coping with making sense of abstract concepts. Moreover, science is constantly changing to adapt to new discoveries and methods, hence some misconceptions may be due to old ideas or legends.

The term 'misconception' is used to encompass both those alternative conceptions that may arise from formal interventions, such as classroom study, and those that are a result of students' own interactions with and observations of their environment.

Teachers often discover that many students show misunderstanding on a number of concepts. When there is misunderstanding, it can be persistent and can readily affect the student's understanding of the lesson or subject. When students fail to understand a concept, they tend to employ a rote learning strategy in order to pass their examinations. Teachers can be astonished to learn that despite their best efforts, students do not grasp fundamental ideas covered in the class. Even some of the best students give the right answers but are only using correctly memorized words (Arnorsdottir, et al, 2004). A significant number of

misconceptions are widespread and tend to be tenacious, some persisting in students up to the university levels.

According to Nap (2000), misconceptions can be categorized as follows:

- *Preconceived notions*
- *Nonscientific beliefs*
- *Conceptual misunderstandings*
- *Vernacular misconceptions*
- *Factual misconceptions*

Biggs (1999) reported that in the course of knowledge construction, students inevitably create misconceptions which need to be corrected. But first, one has to find out what they are by formative assessment. This does not necessarily mean formal teaching, although trial runs on final assessments can be useful, but probing students' knowledge as it is being constructed, so that any misunderstanding can be set right, literally in the formative stage. To do this requires a technique where students will feel free to admit error. If they think they might be graded on the result, they will be very defensive.

Hess and Azuma (1991), as cited by Biggs (1999), defined a technique used by Japanese teachers called 'sticky probing'. A single problem is discussed for hours by students, with the teacher mediating, until a consensus acceptable to teacher and students is reached. The focus of the probing is a particular students' error, which the teacher believes would be instructive to unpack and reconstruct

publicly, with the students' focus of public correction. Japanese students don't appear to see this as a punishment for making a mistake, but as part and parcel of learning.

Tabor (1998) pointed to the strong preference of most of their students for common sense reasoning, everyday analogies, visible effects and changes, and common nonscientific word usage. He observed that students actively rejected the use of scientific vocabulary in favor of colloquial speech, which led them into many misunderstandings.

Along this line, Schmidt (1997) discussed how misconceptions form a meaningful and coherent alternative framework in students' minds, which is very hard and difficult to change. He then focused on the role of everyday meanings of words in fostering misconceptions.

Johnstone (1993) noted that some current researchers have begun to look beyond the classification of misconceptions toward understanding what underlies the difficulties that students have when approaching complex topics such as chemical equilibrium, molecular orbital theory, or reaction kinetics. In particular, chemistry education research has shifted focus to explore students' specific difficulties with understanding the representations of chemical phenomena at multiple levels as well as the forms chemists give these representations. Experienced chemists take for granted that chemical phenomena occur at multiple levels – the submicroscopic, the macroscopic, and the symbolic. Johnstone's

model for the nature of chemistry, involving macro, sub micro and symbolic aspects, suggests that successful problem solving requires mastery of all three.

In addition to Johnstone's report, Banerjee (1995) added that although chemists may easily discern the relationships between chemical phenomena at the symbolic, submicroscopic, and macroscopic levels and represent the phenomena with several representations, students have considerably more difficulty.

Ahtee and Varjoli (1998) found that approximately 10% of eighth graders in Finland failed to distinguish between substances and atoms. The same percentage of secondary school students and university students made the same mistake.

According to Sue-Ho (1999), student teachers who opted to major in science are entering the college with misconceptions about a number of basic chemistry concepts. Analysis of examination scripts of first year students over the past eight years has revealed that some misconceptions persist even after instruction. This is of concern since misconceptions affect their ability to gain a sound understanding of the subject matter and, if not addressed, will hamper their chances of becoming effective chemistry teachers, and will lead to transmission of and perpetuation of misconceptions.

Harrison and Treagust (1996) classified the kinds of models which can be built of a physical phenomenon, and then observed how the students used various models and types of models to build a picture of a phenomenon. They deduced

that none of the 48 students completing a chemistry course had come to understand that the models they were using were only models which served the development and testing of ideas, not the depiction of reality. Only one of the 48 seemed to be on the verge of achieving this understanding.

Bodner's (2003) work, spanning nearly 20 years, studying freshmen through to graduate students, and covering chemistry domains (general, organic, inorganic, and physical) indicates that successful problem solving is linked to the number and kinds of mental models that students have.

Hong Kwen Boo (1998) emphasizes that students have a difficult time understanding the abstract concept of energy, and to the difficulty students have in bridging the gap between perceptual thinking and the use of "concepts about particles and their interactions." He said that students failed to understand the nature of sciences as a process of construction of predictive conceptual models and the nature of scientific concepts and principles, that is, their applicability across the entire range of chemical phenomena.

In their article on Connected Chemistry, Stieff and Wilensky (2000) noted that considerable research has been devoted to identifying and classifying misconceptions in chemistry. To this end, educational researches have underscored how traditional chemistry curricula, replete with lectures and drill-and-practice exercises, are unsuccessful at providing students with a solid conceptual understanding of the theories and expressions found in chemistry.

Unfortunately, despite decades of research and curriculum development, students today still do not adequately learn the necessary concepts to succeed in this field.

Misconceptions also arise from preconceptions. Students enter a class with physically incorrect and/or inconsistent alternative conceptions about the workings of the world around them. These preconceptions form the mental framework, the scaffolding on which students build all subsequent knowledge.

Alternate frameworks come in 2 varieties: misconceptions about what actually happens, and alternative explanations of what happens. In the former case, the concepts are simply empirically wrong; in the latter situation, the notions may be internally consistent but contrary to chemists' accepted views (De Jong, 2000).

The constructivist view of learning leads to the expectation that it is not easy to bring about a reconstruction of a misunderstood concept already embedded in the mind (Tomlinson et al., 2000).

Students can also get their misconceptions from the media, where the reporters don't use the right definitions for the concepts. Students, then, try to construct meanings of concepts based on their perceptual experiences (Go, 2001).

Other sources of these misconceptions can, in many cases, be traced to textbooks or to teachers, who may have presented the concept incomprehensibly or incorrectly. "Defective textbooks blot the educational landscape like booby traps and land mines. Faulty books destroy minds mincingly but, overtime,

extensively, like the misty rain, coming softly but flooding the river. What seems to be more confusing to students is that text and instructors often do not point out the nature of the simplification being presented" (Go, op cit).

Misconceptions in any field in science are a continuous phenomenon and may be caused by several other factors. But whatever the misconceptions are, the key to success is ensuring that students are constructing or reconstructing a correct framework for their new knowledge (Science Teaching Reconsidered, 2000).

Hence, a stronger emphasis on the basic concepts must be focused. This study attempts to highlight where student understanding of fundamental concepts of matter and chemical reactions differ from accepted scientific concepts in order to aid instructors in the development of new and better curricula that bring students more rapidly to a simpler desired understanding.

<u>On Attitude Toward Chemistry</u>

According to Novak (1999), there are two extreme attitudes toward Science/Chemistry:

1) Baconian Vision (after philosopher Francis Bacon) states that the progress of mankind can be only achieved through the development and application of Science and Technology in the exploitation of natural resources. *Knowledge is power!* The improvement in the physical environment will subsequently lead to better social environment and to the more humane society.

Most scientists and governments subscribe to this belief which originated during the Age of Enlightenment in Western Europe.

2) Frankensteinian Vision (after the novel by Marie Shelley) expresses concern at unrestrained development of Science and Technology (*"Man playing God"*) and points out the role of Science and Technology in the development of weapons of mass destruction and environmental degradation. Many people in the Green Movements subscribe to this view of science.

As cited by Holt (2005), the term 'attitude' deals with a disposition to react favorably or unfavorably to a class of objects. She expanded on this idea by stating that attitude is an outcome of the categorization process, this process being influenced by the social environment. Attitudes can be classed as items of social knowledge that are continually formed, strengthened and modified. They can therefore be defined as mediated reactions that have been strongly influenced by social context. Attitude is a means of adjusting to and making changes in one's social environment. It is does learnt and can often persist, however it can also be modified by experience.

Favorable or unfavorable dispositions toward a school subject influence students' academic performance. Quisumbing (1986) described the role of attitude, thus:

> *Attitude involve both affective and cognitive components. These components interact intimately with one another, so that cognition about attitudinal objects are not felt to be*

> *meaningfully analyzable without considerations of affective forces… and thus attitude is defined as an enduring organization of motivational, emotional, perceptual, and cognitive processes, with respect to some aspects of the individual world.*

According to the Chemistry Education research (2005), one of the major concerns in the chemistry community internationally has been the decline in the status of chemistry as an "enabling science". What is most relevant is the decline in the staff/student ratios and correlated funding. Although this problem has many facets, two of the challenges are to teach in a comprehensive manner, as well as to attract and retain chemistry undergraduate students.

Banya (2005), in a study on the factors affecting attitudes of high school female students toward chemistry, noted that chemistry is a human endeavor that relies on basic human qualities like creativity, insights, reasoning and skills. He added that chemistry depends on habits of the mind: skepticism, tolerance of ambiguity, openness to new ideas, intellectual honesty, curiosity, and communication.

Durrani (1998) noted that the declining popularity of science is a well-known fact. He observed that the number of 18 year-olds taking science and math at A-level in England and Wales fell from 42% in 1963 to just 16% in 1993.

In his study on the attitudes and views of medical students toward science, Peña (2005) concluded that there are students who showed favorable attitudes toward science, as most respondents claim to repute science as the best source of

knowledge. Nevertheless, he noted that a sizable portion of students have some reservations concerning science and technology since more than half of the respondents think that science has made lives more stressful and they believe that most scientists serve political power.

In a recent survey on what professional chemists do, Meakins (1996) found that there was an over-all positive attitude towards chemistry with the majority of those polled being aware of the benefits that chemistry can bring.

Osborne et al (1998), in their article Attitude to Science: Issues And Concerns summarized young people's attitude to science, how these affect subject choice and achievement. The authors concluded that the recent introduction of Compulsory Science Education to 16 year-olds in England, Wales, and Northern Ireland has not succeeded in changing the level of interest in science and that attention needs to be turned to the content of the curriculum to make it more relevant and engaging.

Rivera's (2000) study on Psychosocial Learning Environment in Chemistry Classroom in the Philippines showed that attitude is directly related to chemistry achievement and that learning environment is directly related to attitude and chemistry achievement.

On Students' Academic Performance

The following works present the general atmosphere affecting the academic performance of students.

It is said that the performance of an individual is the result of the interplay of simple responses such as habits, motives, attitudes, emotions, language, and personality, all of which are the products of learning.

For this reason, individuals differ in all sorts of ways, and any one of these differences may affect how well he performs in his work, in his studies, and even in society (Etulle, 1995).

Nebres and Vistro-Yu (1998) stated that various assessments and surveys report downward trends in student performance in science. The results were found to be consistent, but a major concern is whether such results are used as a starting point when new programs and activities in science and math education are organized.

Tomlinson et al (2005) concluded that improved student performance in general chemistry courses is correlated in varying degrees with higher reasoning ability, better math skills and logical-thinking ability, previous chemistry background, better attitudes about the course, as well as higher placement examination scores.

Hahn and Polik (2004) also cited that in physical chemistry, logical thinking ability as well as previous successful courses in math and physics, students' study skills and motivation were shown to be predictors of success.

According to Mastroprieri and Scruggs (2000), students at risk for school failures come from diverse environments and they represent all racial, ethnic and

linguistic background. Capel et al (1996) identified the term “at risk” in the following ways: low educational attainment and self-esteem, dwindling participation in school activities, truancy, dropping out, behavioral problems and delinquency.

Capel et al (op cit.) wrote that the authors of the report for the Organization for Economic Cooperation and Development identified factors that could be used to predict the aforementioned outcomes. These factors are family poverty, ethnic minority status, single parenthood, uneducated parents, cramped housing, no relations between home and school, physical and mental abuse, poor grasp at the language instruction, the type and location of the school and community failings.

Weis (1995) stated that some pupils have a more positive attitude toward school and learning. These pupils are therefore more likely to work hard, behave in the classroom and succeed in education. Right attitude and perseverance are responsible for approximately 75% of achievement.

Marks-Beale (2002) said that the learning-how-to-learn skill of a student help him succeed in his academics. Possession and use of effective and efficient learning skills mean that the person feels confident in his ability to learn and he spends less time learning more. These skills are learning by doing, discovering is learning style, creating concentration, learning time management, smart studying, taking notes from lectures, taking notes from reading materials, reading

comprehension skills, survival reading skills, mastering tests, using his creative and critical mind, finding information on the web, and writing in the real world.

According to Burger (2000), researchers find differences in academic performance between Type A and Type B college students. He wrote that such investigation found that Type A students receive more academic honors and participate more in extra-curricular activities than Type B students. Type A people are strongly motivated to overcome obstacles, driven to achieve and meet goals, attracted to competition, enjoy power and recognition. They are easily aroused to anger and action, dislike wasting time and do things in a vigorous and efficient manner, and find more easy-going people a source of irritation. Type B people are relaxed and unhurried, work hard on occasion and Type B's are less likely than Type A's to seek competition or to be aroused to anger or action.

Cohen et al (1996) pointed out that ability and motivation are inseparable partners in the pursuit of academic success. As such, a number of instruments are designed to look beyond ability and toward factors such as habits, interests, and attitudes. These instruments are based on the following premises:

- Good students are the best judges of important and effective study techniques.
- The child's interests help the teachers design instructional activities.

- Positive reaction to school may increase the likelihood that students will stay in school, develop a lasting commitment to learning, and use the school setting to advantage.

Helmenstine (2005) identified top five reasons why students fail chemistry. These include cramming or trying to absorb chemistry concepts in the least available period, insufficient math preparation, not reading the textbook, negative attitude towards chemistry, and unable to do one's work alone.

Brady (2005) emphasized that teacher factors that include teachers' characteristics are linked to effective learning and academic achievement.

According to Elliot et al (1996), schools are effective when teachers staff them because there is a link between teacher characteristics and a smoothly functioning classroom contributing to students' achievement.

Beerens (2000) added that education reformers say student achievements are imposed when teachers' performance and quality are also improved.

Steinberg and Noguera (2000) shared their different and yet complimentary perspectives on the cultural, familial, and institutional factors that have the most potent influence on student learning and academic performance.

Furthermore, Steinberg (2000) discussed that the parental involvement that makes the biggest difference in student performance at the high school level is the type that actually draws parents into schools physically: attending school

programs, watching their kids in extracurricular activities, and showing up for parent-teacher conferences.

Thorkildsen et al (2002) reported that family stability, regardless of whether children live in non-conventional, conventional, or single-parent households, has been associated with high grades in school. When adults continuously talk about how children can do their work, children who have difficulty sustaining attention are likely to persist on difficult tasks. Moreover, children benefit when adults help them select learning-oriented rather than performance-oriented goals and offer feedback on the effectiveness of their choice strategies.

According to Elliot et al (op cit.), the extent to which the parents support the schools objective directly affects their children's academic performance. He stated that low parental expectations for their children often reflect the parents' own educational experiences. If parents themselves encountered difficulties in school, they may exercise a negative impact on their children's attitudes, expectations, and performance.

According to Jones and Jones (2001), the Coleman Report is perhaps the best-known study of the effect of peer norms among high school students. This study shows that the major factors are the socio-economic composition and achievement orientation of fellow students. When students attend schools in which academic achievement is valued, their interest in academic endeavors and

their academic achievement increases. Similarly, attendance at schools in which academic performance is not valued tends to decrease students' academic interest and achievement.

Asher and Cole (1990), as cited by Seifert (1999), stated that students who are extremely withdrawn socially or are actively rejected by their peers tend to perform less well academically and think poorly of themselves socially.

Steinberg (op cit.) reported that the contemporary American society pulls teenagers away from schools toward social and recreational pursuits. There is widespread peer pressure not to succeed academically. One of five students says that their friends make fun of people who try to do well in school. More than one-half of all students say they never discuss their schoolwork with friends.

Steinberg (op cit.) also stressed that one of the worst offenders distracting youngsters from academics is after-school employment. He found that students who were working more than 20 hours a week were earning lower grades, spending less time on homework, cutting class more often, and cheating more frequently. However, he cited that this scenario happens in a country where this level of working during school is commonplace, especially among students who have their sights set on continuing their education beyond high school.

Guskey (2000), in a recent research by the Consortium for Policy Research in Education in 1996, pointed to certain practices that boost student achievement. These involve: (1) making achievement the school's primary goal

which includes developing specific objectives among teachers, parents, and members of the community, and then developing a comprehensive plan for meeting these objectives, (2) enhancement of the curriculum and making sure students are engaged in challenging academic programs, and (3) the appropriate management of money, resources, people, and time at the school levels. The principal should serve as facilitator of this process, rather than as an authority figure that makes all of the important decisions. Most importantly, the work of the teachers must focus directly on increasing student learning.

The question posed by Orduña (1994), "How can learning occur effectively and efficiently so the performance yields are superior?" is a challenge to every institution engaged in education.

Though there are factors that affect an individual's performance, the degree of such factors differs for every individual and may become sharpened or suppressed in the process of learning or even as the individual is beset by factors such as gender, ethnic affiliations, educational background, and parents' educational attainment (Segnaben, 1996).

On Ethnicity

Aimé Césaire (2004) quoted, "No race holds the monopoly of beauty, of intelligence, of strength, and there is place for all at the rendezvous of victors."

In an article by Detterman (2004), he noted the numerous researches which have found differences in measured IQ between different self-identified

racial and ethnic groups. However, he concluded that a person's racial or ethnic identification cannot be used to infer his or her intelligence.

With the publication of *The Bell Curve* (1994), authors Herrnstein and Murray wrote that some of the racial differences in average IQ were partly due to genetic factors.

Some scientists believed that the causes of racial and ethnic differences in IQ scores are entirely environmental. In this view, certain racial and ethnic groups do poorer on IQ tests because of cultural and social factors that put them at a disadvantage, such as poverty, less access to good education, and prejudicial attitudes that interfere with learning (Encarta, 2004).

In a research on why some ethnic groups, particularly Asian Americans, perform very well academically compared to other groups, Detterman (op cit) pointed to Asian cultural values and family practices that place central importance on academic achievement and link success in school with later occupational success.

In his article, Trachtenberg (2005) said that subtle reminders of common cultural stereotypes can affect students' academic performance.

Dr. Leman's (2003) analysis on the Indicators of Academic Performance showed that, in different subject areas, the students' gender, ethnicity, and to a lesser extent the type of school they attended, interact in different ways to produce variations in academic outcomes depending on the subject area.

In her study analyzing racial and cultural identity, Oyserman (2005) concluded that minority youths get better grades in school if they have seen their racial identity as connected to academics. She observed that when students are made to focus on their status as both an in-group member and a member of a group that is discriminated by a larger group, a positive sense of belonging develops and further leads to improved academic performance.

Conceptual Framework of the Study

Each individual has inherent capabilities that may influence his comprehension, behavior, and consequently his performance in every undertaking he engages himself in. A student's future success lies in his performance even as he is surrounded by several factors that may affect his behavior or performance.

Conceptual change should become more plausible, more intelligible, and more fruitful for the students. The formation of new concepts, particularly in science, is based on building the foundation of old ones.

This study was meant to generate an awareness of some of the common misconceptions found in General Inorganic Chemistry, specifically on basic physical concepts and matter and chemical reactions, and aimed to determine the extent by which these misconceptions or alternate conceptions are affected by factors such as attitude toward chemistry, academic performance as measured by the student's final grade in General Inorganic Chemistry, and student's

background which includes high school grade in chemistry, ethnic background, and parent's educational attainment.

The level of attitude of engineering students of the University of Baguio toward a basic chemistry course was determined, as well as the extent to which attitude affects misconceptions in chemistry. Is it merely to satisfy a requirement? Thus, getting a passing grade maybe a student's only motivation for studying chemistry.

Figure 1 shows the research paradigm.

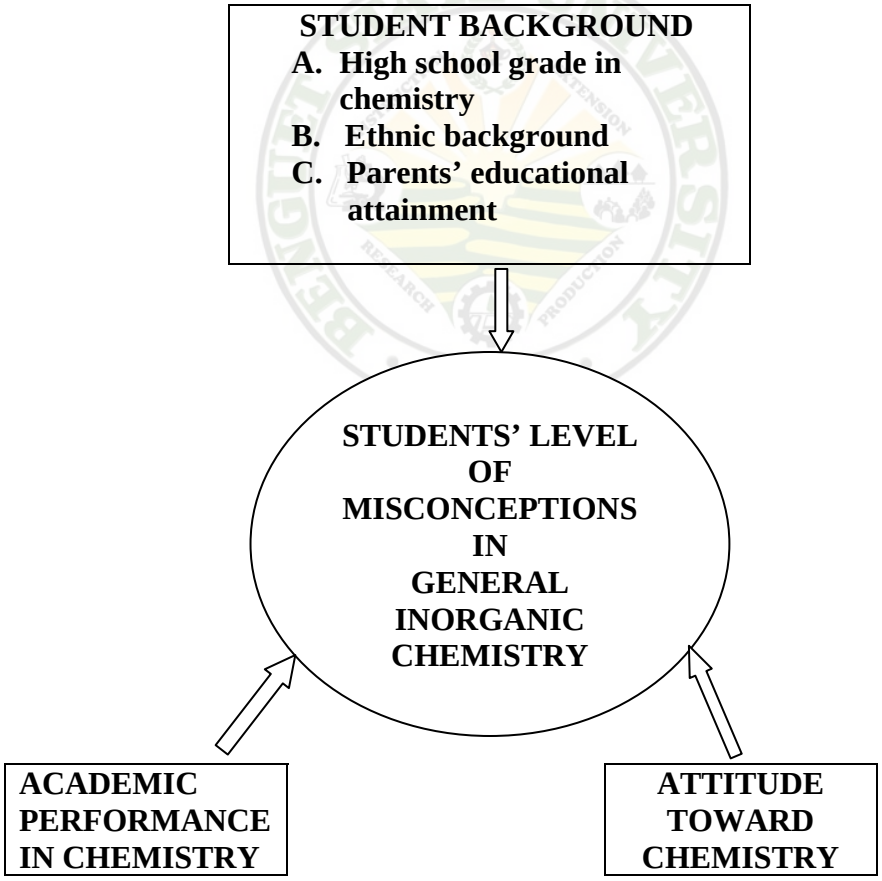

Figure 1. Research Paradigm

Definitions Of Terms

Academic Performance. This refers to the knowledge attained or skills developed, usually designated by grades or marks assigned by teachers, as transmitted from the total raw scores. In this study, it is the final grade of the respondents in General Inorganic Chemistry for first semester SY 2005-2006.

Attitude. These are tendencies or dispositions to react favorably or unfavorably to situations. Attitudes also refer to a relatively enduring way of thinking, feeling, and behaving toward an object, group, or idea. In this study, attitudes refer to behavior of the students toward a subject.

Basic Physical Concepts. These are introductory topics discussed in General Inorganic Chemistry which includes the general essence of chemistry, measurements, temperature, density, specific gravity, heat, and energy.

Chemical Reaction. A process in which one or more substances are converted into other substances. This is also referred to as chemical change (Brown et al, 2002).

Educational Attainment. This refers to the educational degree attained by an individual. In this study, parent's educational attainment was used to refer to the highest educational degree reached by either of the parents.

Ethnic Background. This investigates the societal background of the respondent, indicating the social class or group which he belongs. It is based on the cultural background to which the student was brought up by his parents. In

this study, ethnic background referred to being Cordilleran, students coming from the Cordilleras, or Non-Cordilleran, students coming from the other regions.

Frequency. The number of times a particular result occurs in a statistical survey.

General Inorganic Chemistry. This is a branch of chemistry that deals with the study of the structures, properties, and reactions of the chemical elements and their compounds. In this study, it refers to ENGCHM 1 course which covers the scope of General Inorganic Chemistry for engineering students of the University of Baguio, as outlined in the course syllabus. (Appendix A)

Level of student misconception. This indicates the category or rank of the student's understanding on common fundamental concepts in general inorganic chemistry based on the scores of wrong answers the students garnered from the questionnaire.

Level of student attitude. This determines how a student reacts toward chemistry, whether favorably or unfavorably. This will utilize the modified survey attitude by Hand (Appendix C) and rated using a five-point Likert's scale.

Level of academic performance. This represents how the student rated in class based on his final grade in General Inorganic Chemistry (ENGCHM 1).

Matter. It is anything that occupies space and has mass.

Misconception. This is defined as a mistaken idea or view resulting from a misunderstanding of something. Misconception or alternate conception is when

students, teachers or anybody's idea differs from the definitions accepted by the experts. For this study, misunderstandings and intuitive conceptions/alternate conceptions that are not in keeping with the ideas accepted by the scientific community are referred to as misconceptions.

Percentage. The comparative portion or share of an entry relative to a larger group.

Rank. A position relative to others.

Regression Analysis. It is concerned with the study of the dependence of one variable, the dependent variable, on one or more other variables, the explanatory variables, with a view to estimating and/or predicting the mean or average value of the former in terms of the unknown of the fixed (in repeated sampling) values of the latter.

Standard Deviation. A statistical measure of the amount by which a set of values equal to the square root of the mean of the differences' squares.

Research Hypothesis

The following hypotheses guided the researcher in the conduct of this study:

1. Misconceptions on basic physical concepts and matter and chemical reactions of engineering students in the University of Baguio are insignificant.

2. Engineering students in the University of Baguio exhibit positive attitude toward science, in particular, chemistry.

2.1 There are no significant differences in the students' levels of attitude toward chemistry.

3. The academic performance of engineering students of the University of Baguio is fair.

4. There are no significant relationship between the students' levels of misconception and the following variables: attitude toward chemistry, academic performance, and students' background such as high school grade in chemistry, ethnic background, and parents' educational attainment.

METHODOLOGY

Locale and Time of the Study

This study was conducted in the University of Baguio located at General Luna Road, Baguio City (Figures 2 and 3). It was conducted during the First Semester of the school year 2005 – 2006, the week before the final examinations week.

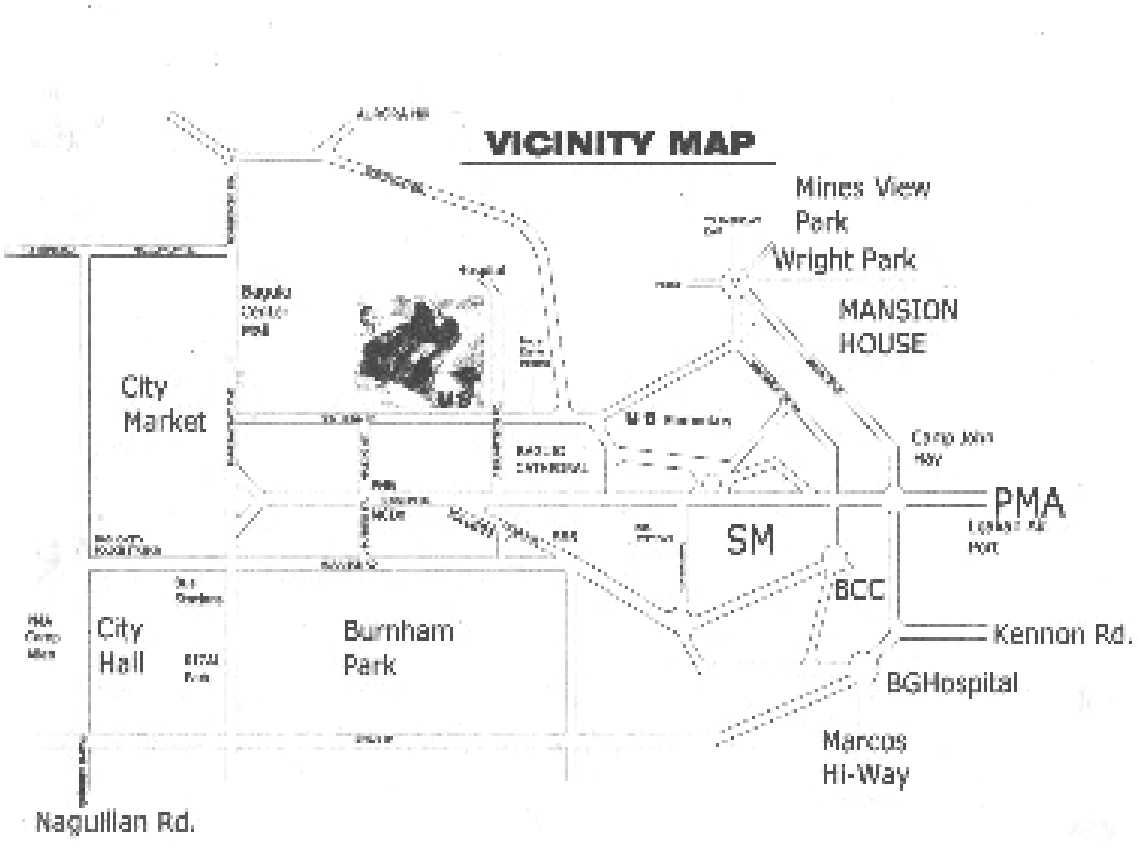

Figure 2. Vicinity Map

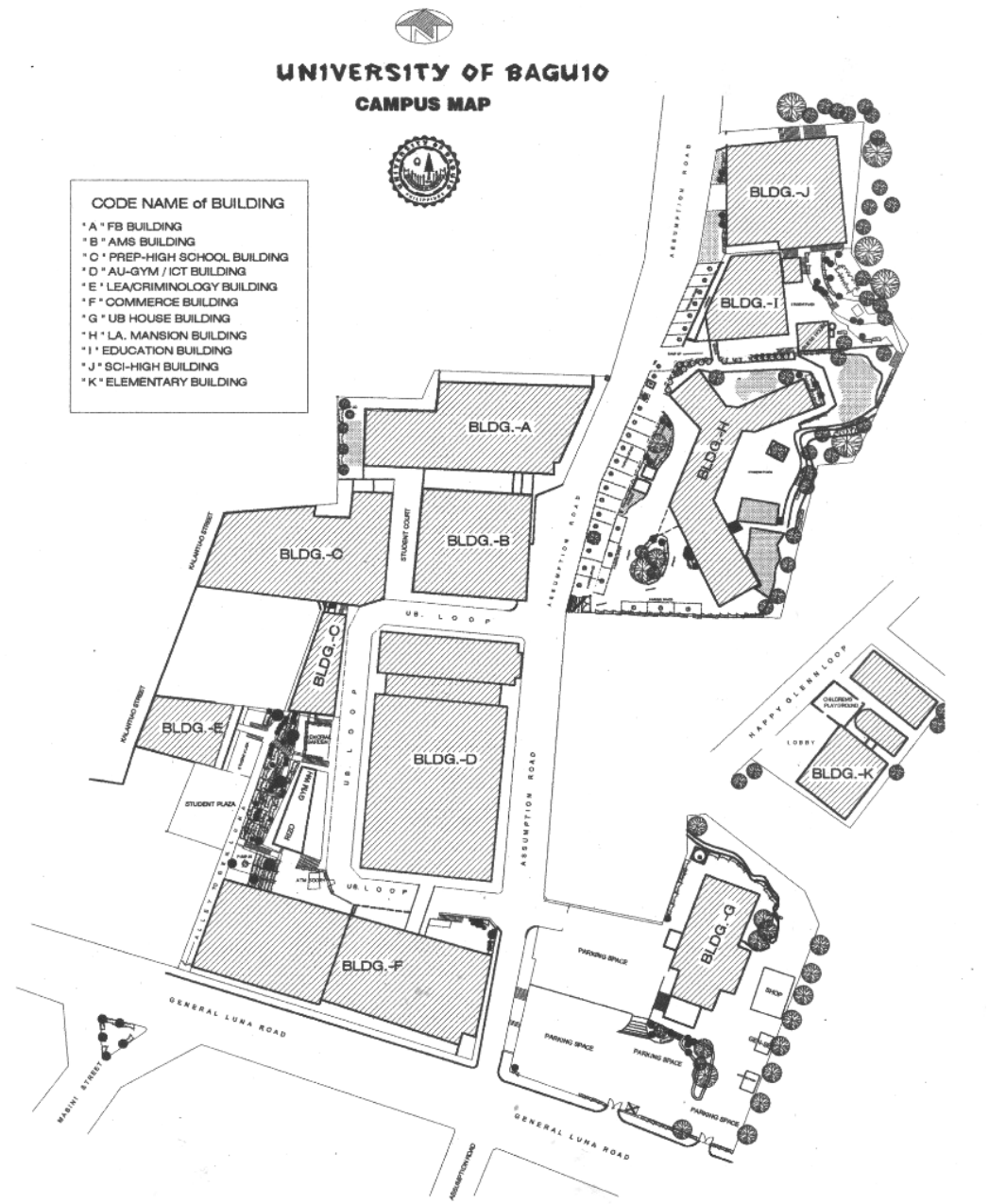

Figure 3. Campus Map

Respondents of the Study

The respondents included the engineering students of the University of Baguio enrolled in Engineering Chemistry 1 (ENGCHM 1) during the first semester of school year 2005-2006. Students from 5 different class sections participated in this study as respondents. Table 1 presents the distribution of respondents from each class. The researcher was handling 3 of the 5 engineering chemistry classes offered for the first semester of school year 2005-2006.

Table 1. Distribution of the Number of Respondents Per Class

CLASS	FREQUENCY	PERCENTAGE
1	28	19.58
2	30	20.98
3	27	18.88
4	27	18.88
5	31	21.68
TOTAL	143	100.00

Research Method

This study made use of the descriptive survey method of research, with the survey questionnaire as the data-gathering tool.

The survey questionnaire (Appendix C) was composed of the following: the respondents' profile or background consisting of ethnic background and parent's educational attainment; the determinants of misconceptions in General Inorganic Chemistry; and the survey on the students' attitude towards the subject

by Hand (1953). The questionnaires were personally administered by the researcher.

To determine student misconceptions, a 40-item questionnaire on selected topics in General Inorganic Chemistry was administered to the respondents one week before the final examination week. The determinants of misconceptions were gathered from the compilation of Arizona State University's key misconceptions and preconceptions in chemistry (2001) and evaluated by science teachers at the Integrated Physics and Chemistry Modeling Workshop held at the Arizona State University.

The student's level of misconception was determined from the scores of incorrect answers obtained by the respondents in the 40-item True-or-False questionnaire, which is composed of 20 items on Basic Physical Concepts and Matter, and 20 items on Chemical Reactions.

The researcher asked permission from the University Registrar's Office to retrieve the respondents' high school grades in Chemistry. Likewise, permission from the University Of Baguio College Of Engineering was sought to float the survey questionnaires.

Statistical Treatment of Data

After the questionnaires were collected, the responses were tabulated and analyzed using frequency, percentage, mean, ranks, standard deviation, chi-square, Z-approximation test, analysis of variance, and multiple regression.

To obtain the level of misconception both for basic physical concepts and matter and on chemical reactions, the following scale was used:

NUMBER OF WRONG ANSWERS	INTERPRETATION
16 - 20	Very highly misconcepted
11 - 15	Highly misconcepted
6 - 10	Moderately misconcepted
0 - 5	Slightly misconcepted to not misconcepted

This scale was interpreted as follows: respondents who get a total of 16-20 wrong answers were considered very highly misconcepted; those with wrong answers ranging from 11-15 were considered highly misconcepted; those with 6-10 wrong answers were considered moderately misconcepted; and those with 0 - 5 incorrect answers were considered slightly misconcepted to not misconcepted.

A test for the significance of the level of misconceptions between Basic Physical Concepts and Matter and Chemical Reactions was done using paired t-test analysis or the Z-approximation test for large samples at 5% level of significance. Under the standard normal table, the critical region at 5% level of significance will be all $|Z| \geq Z_{0.025} = 1.96$. This means that the level of misconception for Basic Physical Concepts and Matter and Chemical Reactions are significantly different when the absolute value of computed *Z* is greater than or equal to 1.96.

The survey on attitude by Hand (1953) was utilized in determining students' attitude towards chemistry. The survey questionnaire was answered using a five-point Likert's scale as follows:

SCALE	RANGE	INTERPRETATION
1	1.00 – 1.50	Strongly Disagree
2	1.51 – 2.50	Disagree
3	2.51 – 3.50	Moderately Agree
4	3.51 – 4.50	Agree
5	4.51 – 5.00	Strongly Agree

To obtain the student's level of attitude (SUMATT), the sum of the student's responses for the twenty questions on attitude survey was computed and the mean was determined. The level of attitude was classified as follows based on the five-point Likert's scale:

1.00 – 1.50 - Worst Attitude

1.51 – 2.50 - Poor Attitude

2.51 – 3.50 - Fair Attitude

3.51 – 4.50 - Good Attitude

4.51 – 5.00 - Excellent Attitude

The respondent's academic performance (CHFINAL) was determined from the respondent's final grade in engineering chemistry for the first semester of 2005-2006.

Based from the University of Baguio's grading system, the final grades were grouped as follows:

Below 75 - Poor

75 - 79 - Low

80 - 84 - Fair

85 - 89 - Good

90 - 94 - Very Good

95 and above - Outstanding

The respondents' high school grade in chemistry (HSGRADE) was grouped as follows:

Below 75 - Poor

75 – 79 - Low

80 – 84 - Fair

85 – 89 - Good

90 – 94 - Very Good

95 and above - Outstanding

Parents' educational attainment (PAREDUC) was ranked according to the highest degree attained by either one of the surviving parent or guardian of the respondent. The assigned ranks were represented as follows:

1 – Up to elementary level

2 – Up to high school level

3 – Up to college level

4 – Up to post graduate level or higher

Chi square test for goodness-of-fit was employed to determine the students' level of attitude toward general inorganic chemistry at 5% level of significance. Two variables being analyzed using chi square are significantly related if the probability values obtained is less than 0.05.

Analysis of variance (ANOVA) was utilized to see if there are significant differences between the moderator variables (ethnic background, high school grade in chemistry, parents' educational attainment, academic performance, and level of attitude) in relation to misconceptions at 5% level of significance.

Multiple regression analysis is a statistical method used to determine the best statistical relation among the variables or simply to know the degree of relationship among variables (Hardy, 1993). For this study, this was used to determine which of the different variables has the most influential effect on student misconception at 5% level of significance.

RESULTS AND DISCUSSION

Common Misconceptions

Basic Physical Concepts and Matter

The distribution of the student's responses on the 20-item questions for Basic Physical Concepts and Matter was tabulated (Appendix E) and the common misconceptions, questions which were wrongly answered by most of the respondents, were identified.

The top five questions that were wrongly answered by most of the respondents were the following:

1. Chemical knowledge is truth.
2. Chemistry is or should be concerned primarily with solving practical problems.
3. Bubbles from boiling water consist of air and oxygen.
4. Temperature is a measure of the body's heat.
5. Mass is conserved but not the number or species of atoms.

Figure 4 shows the graphical presentation of the frequency distribution of the misconception scores for basic physical concepts and matter, where the total numbers of incorrect responses are indicated.

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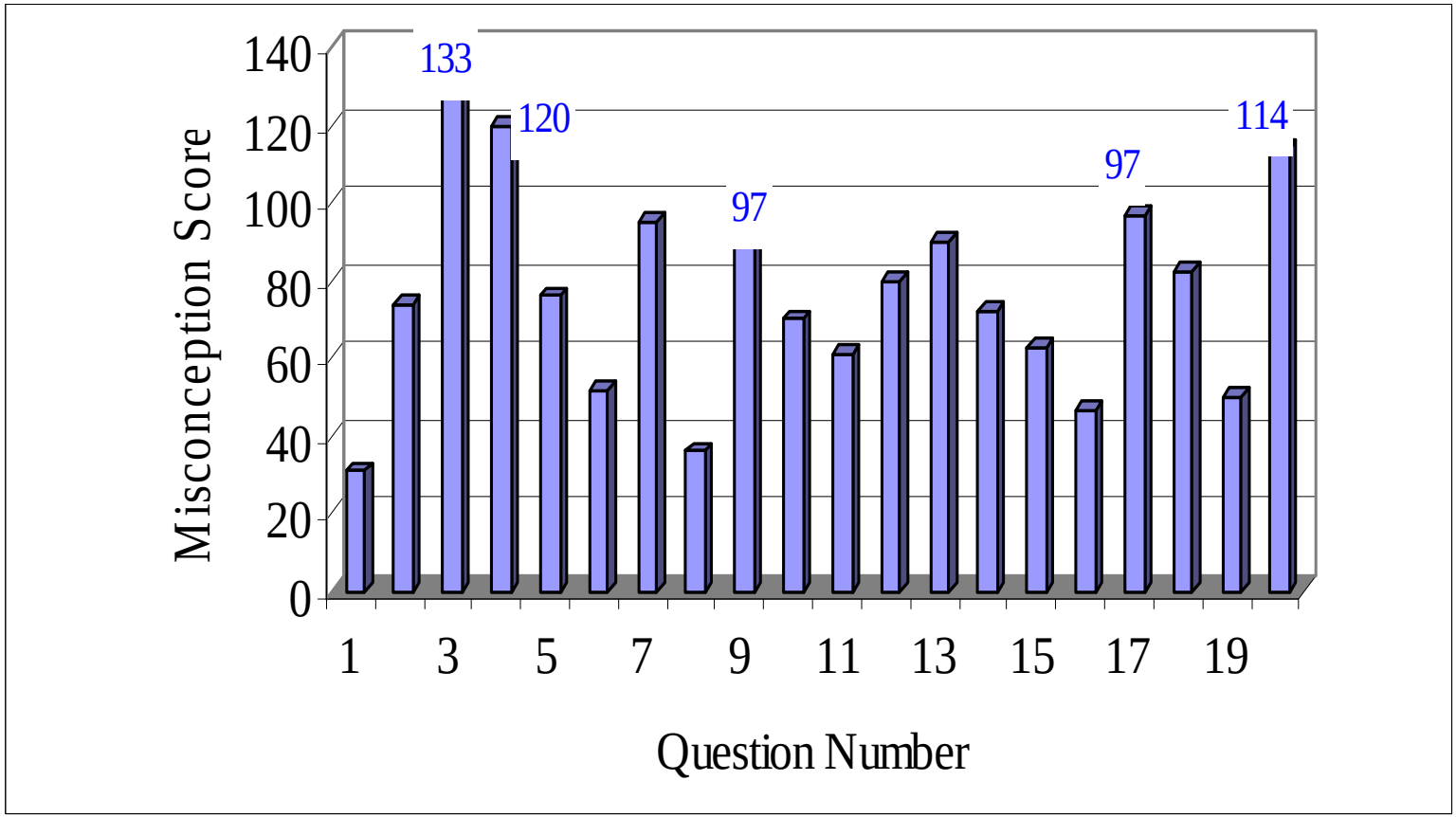

Figure 4. Frequency Distribution: Misconception Scores in Basic Physical Concepts and Matter

Chemical Reactions

The distribution of the student's responses on the 20-item questions for Chemical Reactions was tabulated (Appendix E) and the common misconceptions were identified.

Topping the list of the questions wrongly answered by most of the respondents were the following:

1. Chemical reactions are caused by the mixing of substances.
2. Chemical reactions must be driven by external intervention, for example, heat.
3. Breaking chemical bonds release energy.
4. Chemical reactions are reactions which produce irreversible changes.
5. If a reaction includes oxygen, it is an oxidation reaction.

The frequency distribution of the misconception scores for Chemical Reactions is presented in Figure 5, indicating the scores for the common misconceptions.

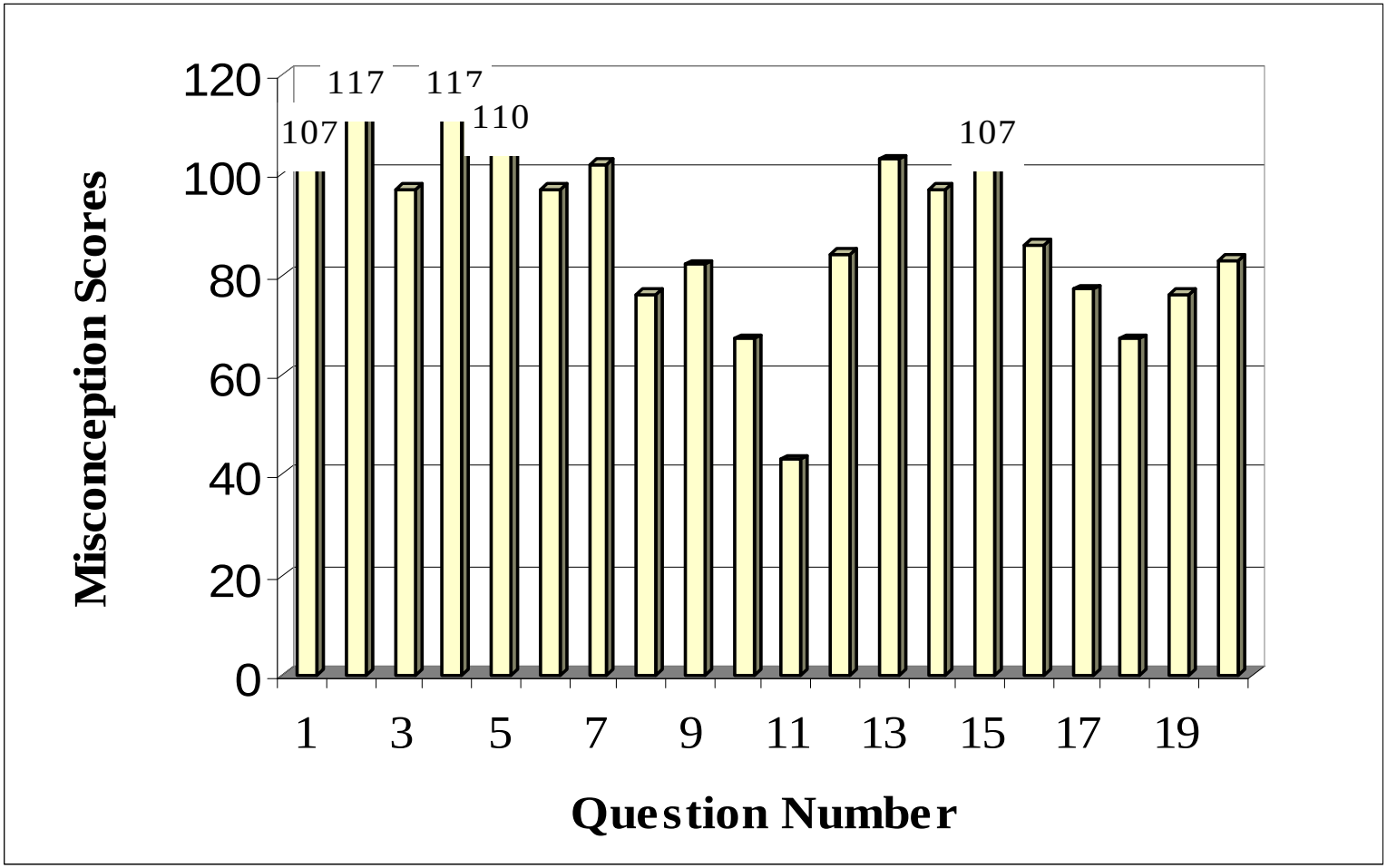

Figure 5. Frequency Distribution: Misconception Scores in Chemical Reactions

Students' Level of Misconception Based on Scores of Wrong Answers To Questions on General Inorganic Chemistry

Basic Physical Concepts and Matter

As presented in Table 2, it can be seen that 60.84% of the respondents (87 out of 143) have incorrect answers between 11-15 out of 20 questions in Basic Physical Concepts and Matter. This means that more than half of the respondents are highly misconcepted and 27.97% of the respondents are moderately misconcepted.

Table 2. Students' Level of Misconception based on scores of wrong answers to questions on Basic Physical Concepts and Matter

SCORES (Wrong Answers)	LEVEL OF MISCONCEPTION	FREQUENCY	%
16-20	VERY HIGHLY MISCONCEPTED	14	9.79
11-15	HIGHLY MISCONCEPTED	87	60.84
6-10	MODERATELY MISCONCEPTED	40	27.97
0-5	SLIGHTLY MISCONCEPTED	2	1.40
	TOTAL	143	100.00

χ_c^2 = 116.5* Probability = 0.00 * significant

Chemical Reactions

As shown in Table 3, for the questions on Chemical Reactions, 63.64% of the respondents (91 out of 143) have wrong answers ranging from 11-15 out of 20 questions, also falling under the category of highly misconcepted and 24.48% of the respondents were very highly misconcepted. This shows that although the misconception determinants questionnaire was administered one week before the final examinations, that is, after all the topics in General Chemistry were discussed, majority still were found to be highly misconcepted. These findings agree with Sue-Ho (1999) who stated that misconceptions persist even after instruction. Schmidt (1997) also mentioned that misconceptions are strongly and persistently held by students.

Table 3. Students' Level of Misconceptions based on scores of wrong answers on questions on Chemical Reactions

SCORES (Wrong Answers)	LEVEL OF MISCONCEPTIONS	FREQUENCY	%
16-20	VERY HIGHLY MISCONCEPTED	35	24.48
11-15	HIGHLY MISCONCEPTED	91	63.64
6-10	MODERATELY MISCONCEPTED	16	11.19
0-5	SLIGHTLY MISCONCEPTED	1	0.69
	TOTAL	143	100.00

χ_c^2 = 130.09* Probability = 0.00 * significant

Results of the chi square test done on the frequency of respondents for each category of Basic Physical Concepts and Matter and Chemical Reactions suggest that most of the respondents are highly misconcepted. This indicates that most students have little to meager understanding of the concepts both on Basic Physical Concepts and Matter and on chemical reactions.

Comparison between misconception scores of basic physical concepts and matter and chemical reactions

The test for the significance of the difference of misconceptions in Basic Physical Concepts and Matter and in Chemical Reactions was computed using the Z-approximation test for large samples at 5% level of significance.

From the standard normal table, critical region at 5% level of significance will be all values of Z in absolute value equal or greater than 1.96. Since the computed Z is equal to -5.609 which is greater than 1.96 in absolute value, then the null hypothesis that the level of misconception on basic physical concepts and matter and chemical reactions of engineering students in the University of Baguio are insignificant was rejected. This implies that the student's level of misconception on Basic Physical Concepts and Matter and Chemical Reactions differ significantly at 5% level of significance. Moreover, from Table 4, the computed means signify that the misconception scores for chemical reactions are significantly higher than the misconception scores for basic physical concepts.

Table 4. Comparison between the misconception scores in Basic Physical Concepts and Matter and Chemical Reactions

PARTS	MISCONCEPTION Scores (Obs)	MISCONCEPTION Mean	MISCONCEPTION Std. Dev.
Basic Physical Concepts and Matter	1540	10.77	9.29
Chemical Reactions	1724	12.06	9.57

$|Z_c| = |-5.609| > 1.96$ Decision: Reject H_O

The result was agreeable to the studies of Johnstone (1993), Banerjee (1995), Harrison and Treagust (1996), and Hong (1998) who wrote that students have more difficulties with understanding complex topics such as chemical phenomena which includes chemical equilibrium and reaction kinetics and their applicability.

Variables Affecting Misconceptions

Student's Level of Attitude Towards Chemistry

The level of attitude of the students toward chemistry was measured using a survey questionnaire of 20 questions (Appendix F).

Analysis of the data gathered showed that the level of attitude of the students towards chemistry, as depicted in Figure 6, tends to lean on fair attitude (44.06%) to poor attitude (36.36%) and only a total of 11.89% has good to

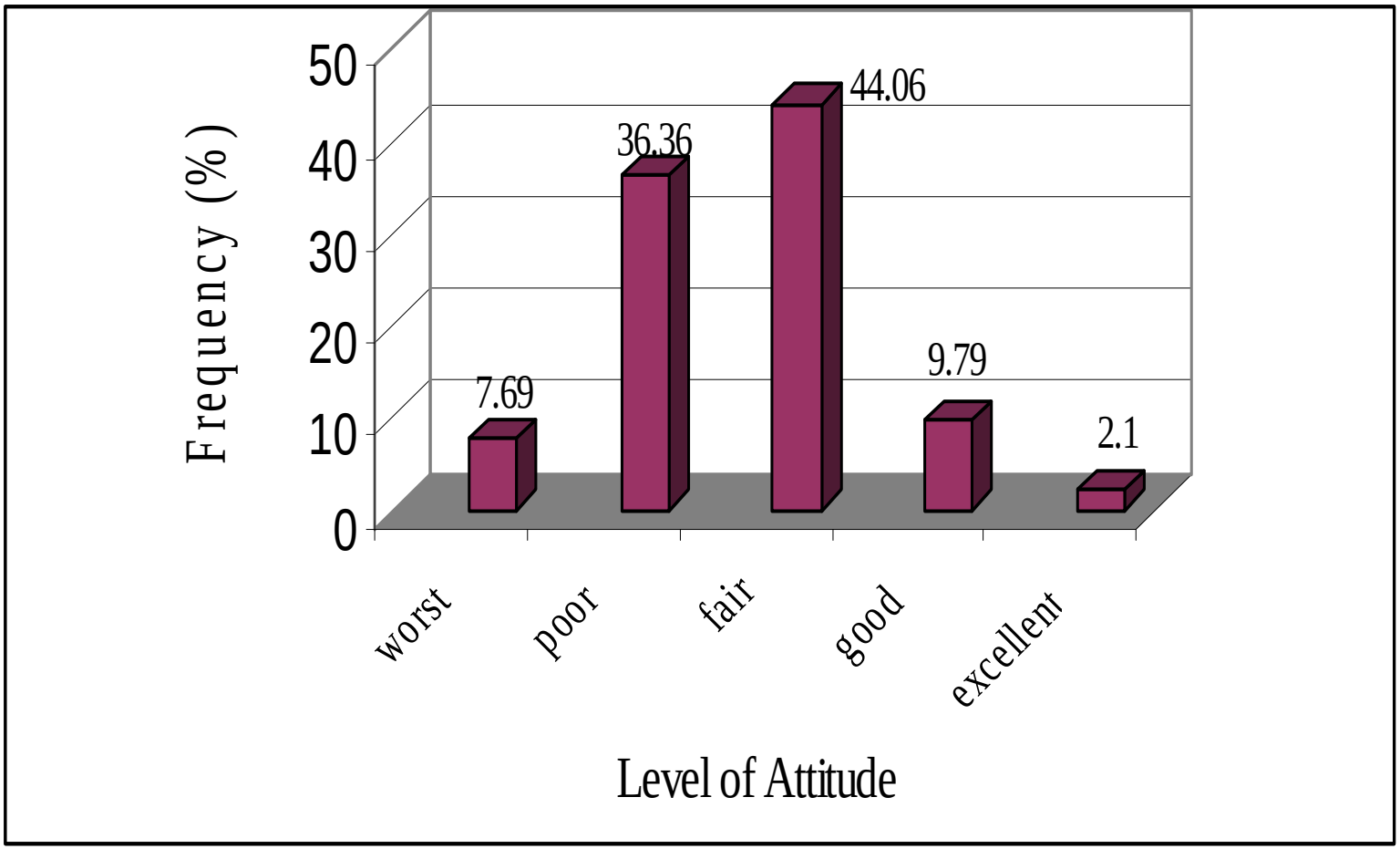

Figure 6. Frequency Distribution: Level of Attitude (SUMATT)

excellent attitude towards the subject. This implies that most of the respondents have poor to fair inclination or interest towards the subject.

The chi-square test statistic (sig. =0.000) in Table 5 strongly suggests that there is a good evidence to support the idea that most students tend to have poor to fair attitude towards Chemistry. As Weis (1995) stated, right attitude and perseverance are responsible for approximately 75% of achievement. Thus, from these results, the null hypothesis that there are no significant differences in the students' level of attitude toward chemistry is rejected.

These findings were supported by the study done by Durrani (1998) and an article in the Chemistry Education Research (2005) which pointed out the declining popularity of chemistry in the science community. Helmenstine (2005) added that one of the top 5 reasons why students fail in chemistry is the negative attitude of the students toward this subject.

Table 5. Student's level of attitude towards Chemistry

OBSERVATION (Groups)	LEVEL OF ATTITUDE	N (Obs.)
1.00 – 1.50	Worst Attitude	11
1.51 – 2.50	Poor Attitude	52
2.51 – 3.50	Fair Attitude	63
3.51 – 4.50	Good Attitude	14
4.51 – 5.00	Excellent Attitude	3
$\chi_c^2 = 101.720$*	(df) = 4 (sig.) = 0.000	*significant

Academic Performance

Academic performance in this study refers to the student's final grade in chemistry for the first semester of SY 2005-2006.

After a semester's course in College Chemistry, it can be seen in Figure 7 that most of the respondents (46.15%) have final grades (CHFINAL) from 75-79 which is categorized as low. Furthermore, 45 out of 143 or 31.47% of the respondents have failed the subject. A total of 20.98% of the respondents (30 out of 143 respondents) have grades 80 and above (fair to outstanding).

These results show that the students' level of academic performance in general inorganic chemistry ranges from poor to low. Thus, the null hypothesis that the academic performance of engineering students of the University of Baguio is fair is rejected.

Student Background

High School Grade in Chemistry. The high school grade of the respondents in Chemistry provides a most useful insight in the students' preparation for College Chemistry. Secondary Chemistry Education is the foundation of the basic principles in general college chemistry.

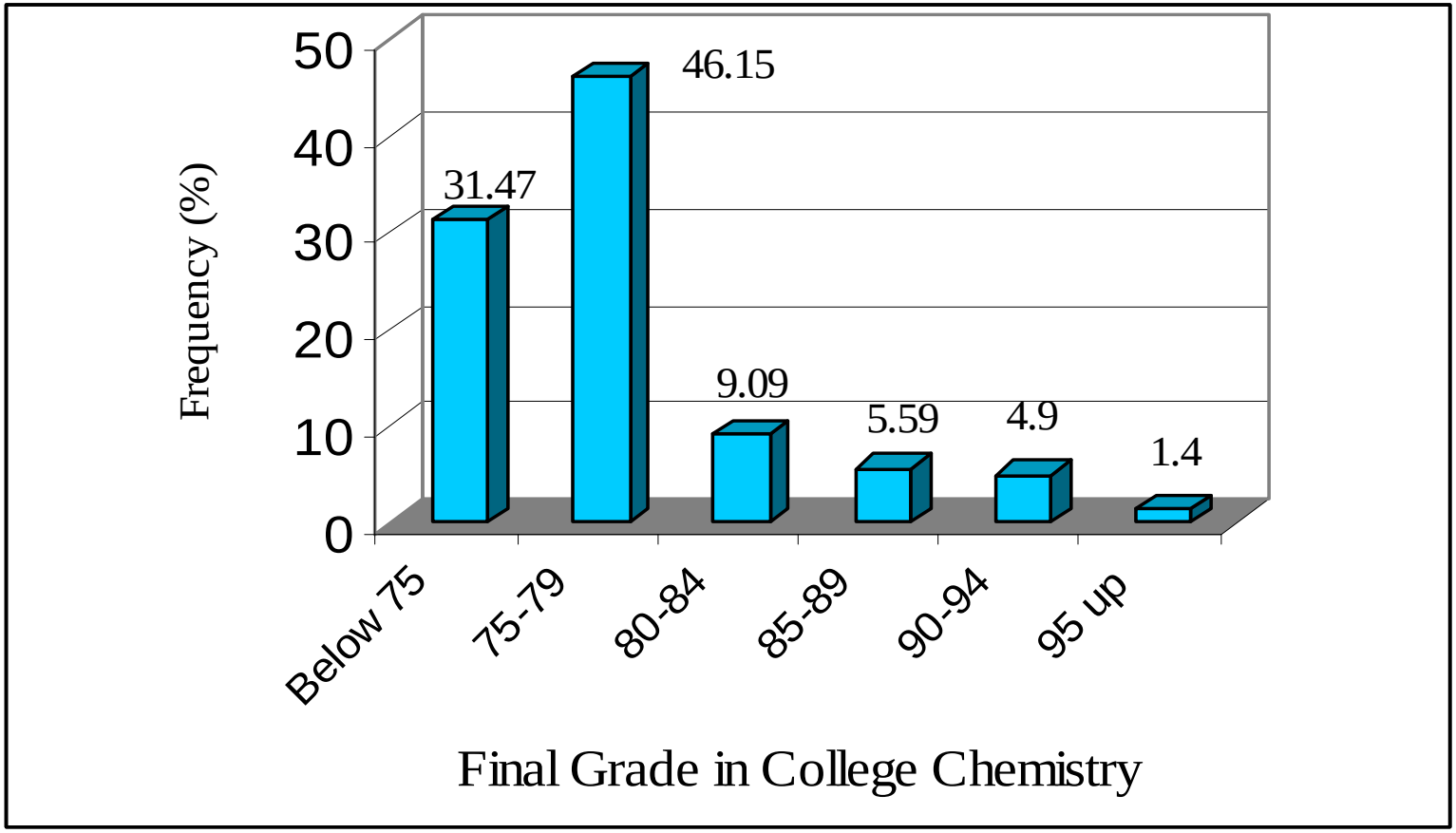

Figure 7. Frequency Distribution: Academic Performance in General Inorganic Chemistry (CHFINAL)

Figure 8 shows the frequency distribution of the respondents' high school grades in chemistry. It is seen that more than half of the respondents have grades between 70-79, that is, 82 respondents out of 143 or 57.34%, from which 39.86% have high school grades from 75-79, which was categorized as low.

Disregarding the effects of other variables, this can be interpreted as that the students' foundation in general chemistry are superficial, hence, the students are not well equipped to tackle college chemistry. Only 22 out of 143 respondents (15.38%) were categorized as good to outstanding, with high school grades from 85 and above.

These findings are supported by the study of Ahtee and Varjoli (1998), who observed that only 10% of 8th graders in Finland can distinguish between substances and atoms. These topics are discussed in the first chapters of high school chemistry.

Ethnic Background. Figure 9 presents the frequency distribution of the respondent's ethnic background. It can be seen that majority of the respondents were non-Cordillerans. This is not surprising, though, since Baguio City is adjacent to the lowlands.

The student's ethnic background was classified as Cordilleran (those student's whose cultural upbringing are from the Cordillera Regions) or non-Cordilleran (referring to students whose cultural upbringing are from the other regions of the country).

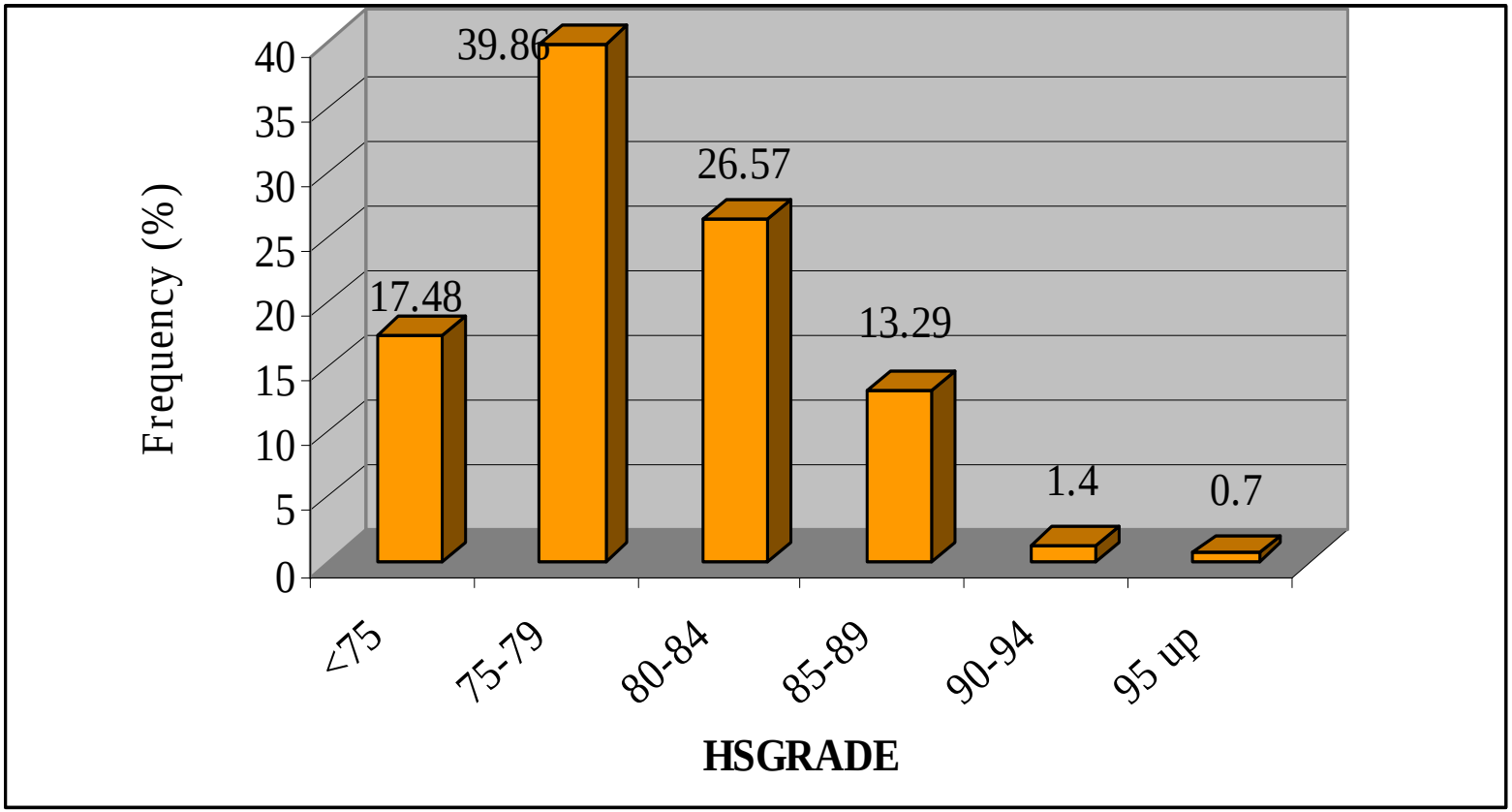

Figure 8. Frequency Distribution: High School Grade in Chemistry (HSGRADE)

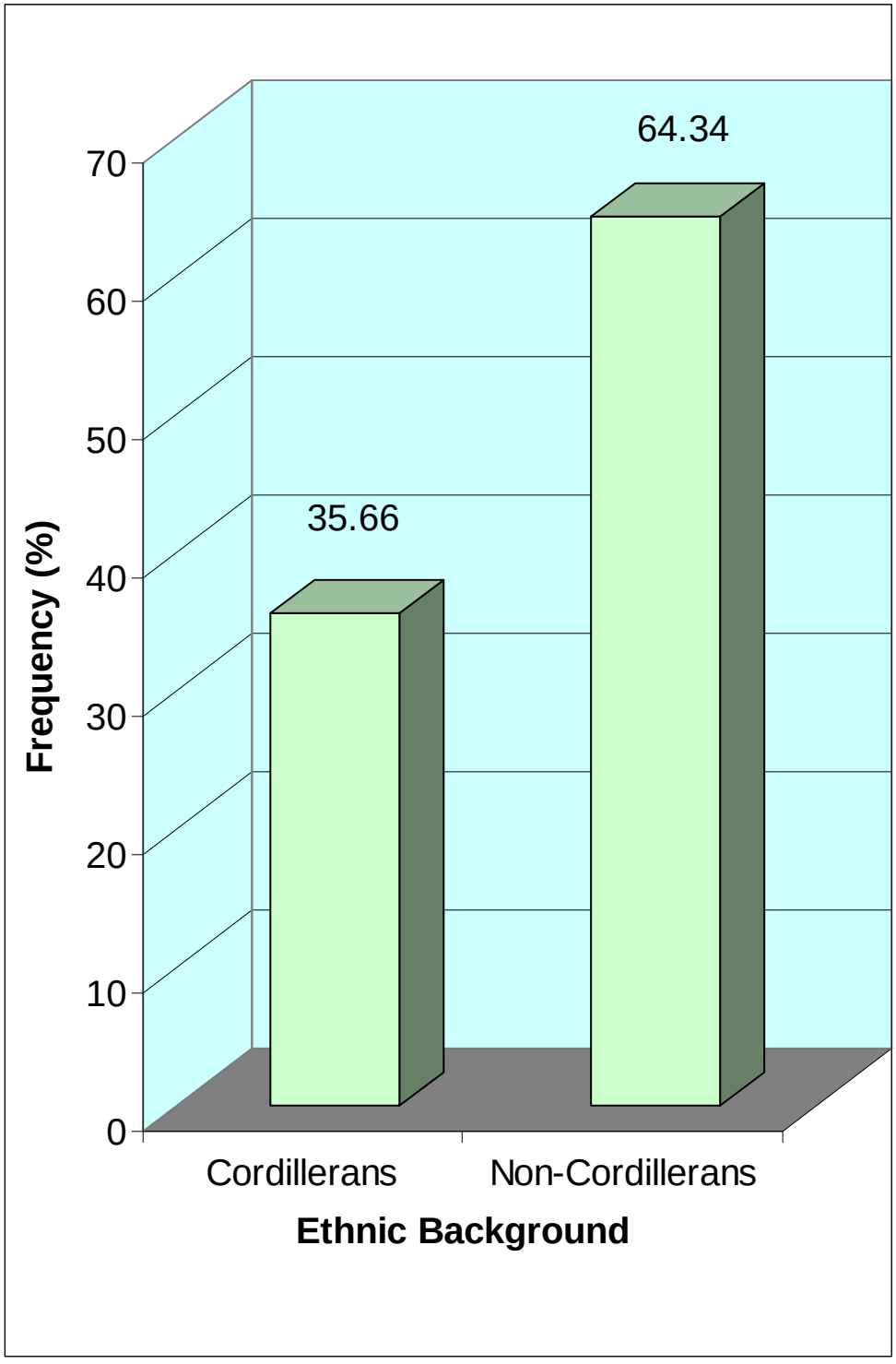

Figure 9. Frequency Distribution: Respondents' Ethnic Background

Ethnic backgrounds coming from the Cordilleras included the Kankanaeys (KANK), Bontocs (BONT), Ibalois (IBAL), Ifugaos (IFUG), Kalingas (KALI), and Itnegs; while the non-Cordillerans included the Ilocanos (ILOC), Tagalogs (TAGA), Pangasinenses (PANG), Pampangos (PAMP), and Visayans (BISA).

Parents' Educational Attainment. In this study, parent's educational attainment referred to the highest educational degree reached by either of the student's parents.

The frequency distribution seen in Figure 10 showed that most of the respondents have parents with at least one parent reaching tertiary education (58.04% UP TO COLLEGE), followed by parents who finished secondary education (UP TO HIGH SCHOOL) composed of 38 out of 143 respondents or 26.57%. Few of the respondents, 4.9%, have parents or at least one of them reaching post graduate studies (UP TO POST GRAD).

Relationship Between Level of Misconception and the Variables Affecting Students' Misconceptions

On Attitude Towards Chemistry

Result of the test done on the students' misconception scores with regards to attitude towards chemistry (SUMATT) indicates no significant difference at 5% level of significance as shown on Table 6.

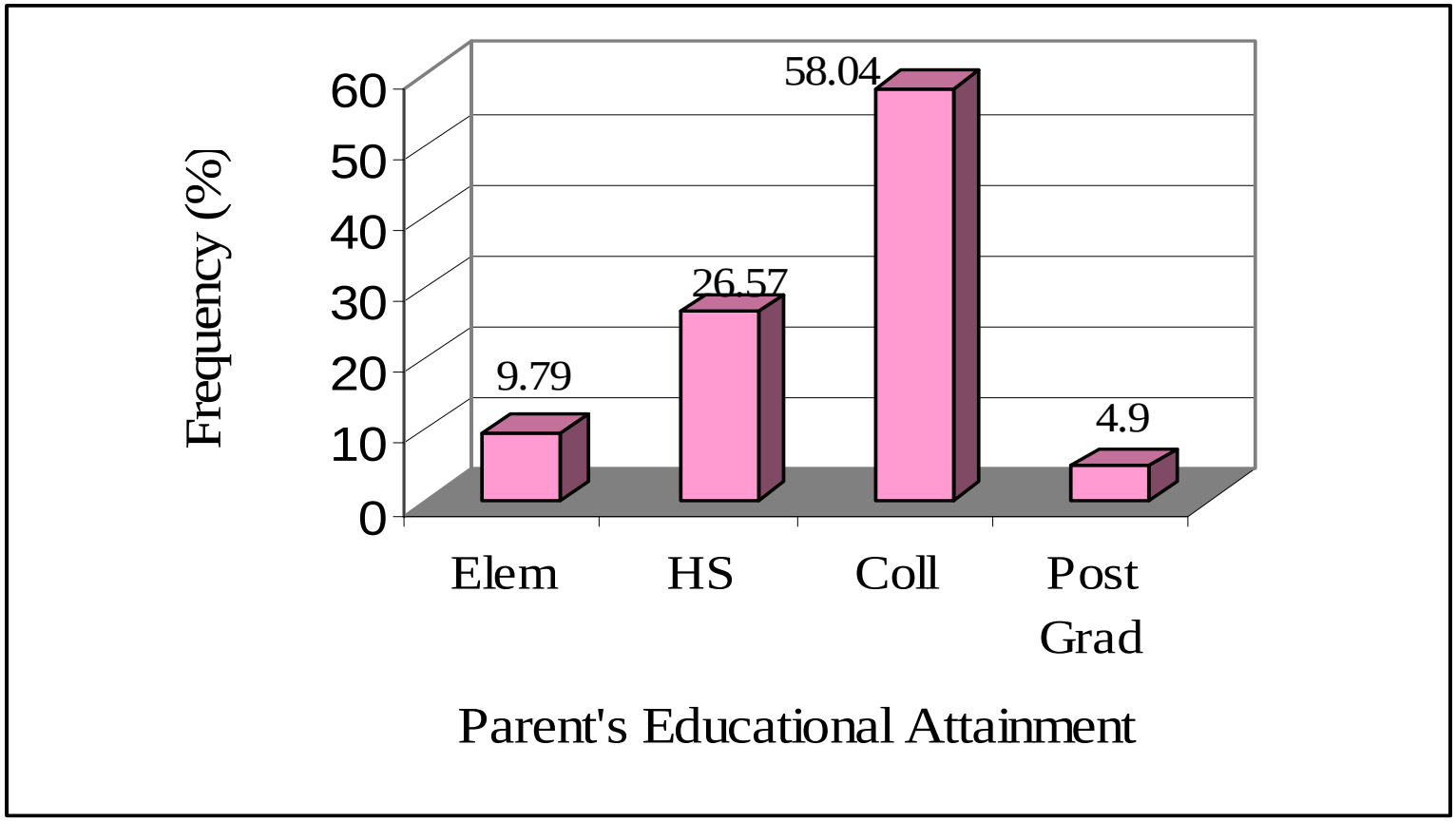

Figure 10. Frequency Distribution: Parent's Educational Attainment (PAREDUC)

Table 6. Average misconceptions according to students' level of attitude towards chemistry

DEGREE OF FREEDOM	SUM OF SQUARE	MEANS SQUARE	F	SIG.
4	50.872	12.718	0.629*	0.643
137	2770.959	20.226		
141	2821.831			

$F_C = 0.629 < F_{0.05,(4, 137)} = 2.37$ Decision: Accept H_O

* not significant

This means that the null hypothesis that there are no significant relationship between the students' level of misconception and attitude towards chemistry is accepted.

The result contradicts the reports made by Etulle (1995), Cohen et al (1996), and Marks-Beale (2002) that the interplay of simple responses such as habits, motives, and attitudes may affect how one performs in his work, studies, or even in society.

On Academic Performance

Result of the test done on the student's misconception with regards to academic performance, as presented in Table 7, indicated that a slight difference in treatment means is observed on CHFINAL (where probability=0.0980), though

Table 7. Average misconception according students' academic performance (CHFINAL)

OBSERVATION (Groups)	DESCRIPTION	N	MISCONCEPTION Mean	Std. Dev.
Below 75	Failed	45	15.82	4.23
75-79	Low	66	16.71	4.89
80-84	Fair	13	16.38	2.14
85-89	Good	8	20.38	4.93
90-94	Very Good	7	19.14	2.67
95 & above	Outstanding	2	16.50	4.95

F = 1.904* Probability=0.098 *not significant

at 5% level of significance, it is still deemed not significant. This means that the level of academic performance do not have an effect on the student's level of misconception.

The finding disagrees with the study done by Leman (2003), that different factors interact in different ways to produce variations in academic outcomes depending on the subject area. Moreover, the study of Tomlinson et al (2005) emphasized that improved student performance in general chemistry is correlated in varying degrees with academic outputs. Segnaben (1996) concluded that factors that affect an individual's performance may become either sharpened or suppressed in the process of learning. Such was also the conclusion of Sternberg's (1998) research who found that an individual's academic performance was relatively domain-specific, that is, people who excel in one area are not

necessarily excelling in another. He added that academic performance is only weakly to moderately correlated with the scores of conventional measures of IQ.

Student's Background

On High School Grade in Chemistry. Test done on the student's level of misconception with regards to student's high school grade in chemistry, as presented on Table 8, indicated no significant difference at 5% level of significance, hence, the null hypothesis that there are no significant differences in the student's level of misconception considering high school grade in chemistry is accepted. This means that student's level of misconception is not affected by the student's high school grade in chemistry. This also implies that even if a student has an outstanding high school grade in chemistry, it does not necessarily follow that he has low misconception scores.

Table 8. Average misconception according to students' high school grade in chemistry (HSGRADE)

OBSERVATION (Groups)	LEVEL	N	MISCONCEPTION	
			Mean	Std. Dev.
Below 75	Poor	25	17.16	3.30
75-79	Low	57	15.98	4.68
80-84	Fair	38	16.66	4.36
85-89	Good	19	18.37	5.27
90-94	Very Good	2	16.50	4.95
95 & above	Outstanding	1	21.00	

F = 1.062* Probability = 0.384 * not significant

On Ethnic Background. The test done for the association of the student's level of misconception to the variable ethnic background, as presented on Table 9, indicated no significant difference at 5% level of significance, thereby failing to reject the null hypothesis. This result implies that the respondents' misconception does not depend on the students' ethnic background or that ethnicity has negligible bearing on the respondents' misconception towards College Chemistry, whether he is a Cordilleran or a non-Cordilleran.

Table 9. Average misconception according to students' ethnic background

OBSERVATION (Groups)	N	MISCONCEPTION Mean	Std. Dev.
Cordilleran	51	15.23	4.18
Non-Cordilleran	92	16.01	3.78
F = 1.135*	Probability = 0.341		*not significant

Attesting these findings was Detterman's (2004) article who noted that a person's racial or ethnic race identification cannot be used to infer one's intelligence. In addition to this, Hermenstein and Murray (1994) wrote that racial differences in average IQ were partly due to genetic factors or environmental factors such as poverty, less access to good education, and prejudicial attitudes that interfere with learning.

However, these results contradict the article of Trachtenberg (2005) and Oyserman (2005) who stated that racial identity can be connected to academic performance and achievement. Likewise, Mastroprieri and Scruggs (2000) wrote that school failures come from diverse environment and they represent all racial, ethnic and linguistic background.

On Parents' Educational Attainment. Result of the test done on the student's level of misconception with regards to parent's educational attainment, as presented in Table 10, indicated no significant differences of the groups at 5% level of significance, hence, failing to reject the null hypothesis. This implies that parent's educational attainment does not affect student's level of misconception in general inorganic chemistry, as indicated by the mean scores.

Table 10. Average misconception according to parents' educational attainment (PAREDUC)

OBSERVATION (Groups)	N	MISCONCEPTION Mean	Std. Dev.
1 UP TO ELEM	14	17.14	3.76
2 UP TO HIGH SCHOOL	38	17.32	5.03
3 UP TO COLLEGE	83	16.37	4.42
4 UP TO POST- GRAD	7	17.00	3.51

F = 0.436* Probability = 0.728 *not significant

These findings contradict Capel et al (1996) who once wrote that single parenthood and uneducated parents could be used to predict low educational attainment of students. Steinberg and Noguera (2000) pointed out that one of the most potent influences on student learning is familial factors such as parental involvement and family stability.

Regression Analysis

Regression analysis is a statistical tool that determines the relationship between variables while analysis of variance is a statistical tool showing only the significant differences among the means. Hence, regression analysis was adopted to show the most influential factors that would affect the students' level of misconception.

Being able to eliminate the variables which showed insignificant results, regression analysis for categorical and ordinal data was employed with the students' misconception test scores as the dependent variable (Y), and student's attitude towards chemistry (SUMATT), and academic performance, as measured by the final grade in College Chemistry (CHFINAL), as the independent variables since these are the variables which are deemed significant to predict student's misconception in General Inorganic Chemistry.

Results of the multiple regression analysis, as presented in Table 11, has shown that the model derived is not that adequate to predict student's misconception in Chemistry since it only explains 6.8% (R= 0.068) of the total

variation of the data. This means that this model will give only 6.8% significance and reliability in predicting student's misconception.

The derived model for student's misconception (Y) is:

Y = 11.867 + 0.150CHFINAL – 0.0926SUMATT

Table 11. Results of Regression Analysis

MODEL				MODEL STATISTICS				
Variables	Unstandardized β	Standardized β	Sig. (t-test)	R^2	ANOVA F	ANOVA Sig.	Durbin-Watson	Ave. VIF
FULL MODEL				0.068	5.05	0.008	1.890	1.028
(constant)	11.867		0.016*					
CHFINAL	0.150	0.227	0.007*					
SUMATT	-0.0926	-0.172	0.040*					

*Significant at 0.05 level.

It can also be seen from Table 11 that regression analysis confirms that variables academic performance and students' level of attitude in chemistry as significant factors which can affect students' level of misconceptions in chemistry. Therefore, the null hypotheses that there are no significant relationships between students' levels of misconception and attitude toward chemistry and academic performance are rejected.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The study was conducted to determine the factors which affect misconceptions in General Inorganic Chemistry among engineering students of the University of Baguio. Specifically, the study aimed to: 1) identify and determine the level of misconceptions in General Inorganic Chemistry on basic physical concepts and matter and chemical reactions; 2) determine the respondents' level of attitude towards chemistry; 3) determine the student's level of academic performance in General Inorganic Chemistry; 4) to determine the relationship between students' level of misconception in General Inorganic Chemistry and the variables attitude towards chemistry, academic performance in General Inorganic Chemistry, and student's background such as high school grade in chemistry, ethnic background, and parent's educational background.

The respondents of the study were 143 engineering students of the University of Baguio who were enrolled in General Inorganic Chemistry (ENGCHM1) during the first semester school year 2005 – 2006. The respondents' high school grades in chemistry were retrieved from the Registrar's Office. All other data were gathered using a personal data sheet and the survey questionnaire, which was administered personally by the researcher the week prior to final examinations. Responses for each item on the survey questionnaire were

consolidated, categorized, tabulated, and analyzed using frequency, percentage, mean, standard deviation, *Z*-test, analysis of variance, and regression analysis.

Descriptive statistics was used for the purpose of giving an initial perspective on which factors affected the respondents' misconceptions in General Inorganic Chemistry. Z-test for approximation was used to determine if there are significant differences between the respondents' misconceptions in Basic Physical Concepts and Matter and Chemical reactions. Chi square test for goodness-of-fit was employed to determine the students' levels of misconception and attitude toward chemistry. Analysis of variance and regression analysis were used to determine the relationship and significance of the different variables on the level of misconceptions in general inorganic chemistry.

The following were the findings from the study:

1. Student's level of misconceptions in General Inorganic Chemistry on the topics of Basic Physical Concepts and Matter and Chemical Reactions is high.

2. The level of attitude of 80% of the students toward chemistry ranged from poor to fair which means that the students have poor inclination or lack interest in chemistry.

3. The level of academic performance of the students in General Inorganic Chemistry, as measured by the students' final grade in chemistry,

ranged from poor to low. Most of the students (46.15%) have final grades from 75-79 and 31.47% failed the subject.

4. Regression analysis showed significant relationships between students' level of misconceptions in General Inorganic Chemistry and students' level of attitude towards chemistry and students' level of academic performance in General Inorganic Chemistry.

5. There were no significant relationships between students' level of misconception in General Inorganic Chemistry and students' background such as high school grade in chemistry, ethnic background, and parent's educational attainment.

Conclusion

Based on the findings of this study, the following conclusions may be drawn:

1. Students are highly misconcepted on Basic Physical Concepts and Matter and on Chemical Reactions. Misconceptions on Basic Physical Concepts and Matter and Chemical Reactions of the students are significantly different. Hence, the null hypothesis was rejected.

2. Students' level of attitude toward chemistry has a significant relationship on the students' level of misconception. Hence, the null hypothesis was rejected.

3. The level of academic performance in general inorganic chemistry ranges from poor to low. In this regard, the null hypothesis is likewise rejected.

4. Since regression analysis showed significant relationships between students' level of misconceptions in General Inorganic Chemistry and students' level of attitude towards chemistry and students' level of academic performance in General Inorganic Chemistry, therefore, the null hypotheses were rejected. However, since ethnic background, high school grade in chemistry, and parents' educational attainment has no significant effect on students' level of misconceptions, the null hypotheses were accepted.

Recommendations

In the light of the aforementioned findings and conclusions, the researcher has the following recommendations:

1. The need for assessment tests should be employed in order to correct the misconceptions of students as early as in the first chapter of the course. These tests may be in the form of pre-assessment tests given on the first day of classes and post-assessment tests to check if such misconceptions have been corrected. If the misconceptions were not corrected early, the students will not only fail to understand, but worse, he is likely to live with it.

2. To arouse the students' interest in chemistry, there is a need for more instructional and audiovisual aids, the use of modern technological gadgets, such as the internet, to update the students on the latest advancements in

chemistry, assigned projects that will enhance the students' creativity, subscription to science magazines to supplement student's classroom learning, or organized field trips.

3. To improve the students' academic performance the use of daily, practical and more concrete examples applicable to the different concepts and theories in chemistry, encouraging peer teaching or group activities, or additional home works to give the low-performing students a clearer and better understanding on these topics.

4. Since there may be other contributory factors which can be considered in identifying, classifying, and determining students' misconceptions in General Inorganic Chemistry, a further investigation of this study on a larger scope is highly encouraged to minimized and correct, or eliminate misconceptions in General Inorganic Chemistry.

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APPENDIX A

I. COURSE NUMBER: ENGCHM1 (3units)

II. COURSE DESCRIPTION: General and Inorganic Chemistry 1 Lecture

III. SCOPE OF THE COURSE:

The course deals with the fundamentals and the basic principles of Chemistry, measurement concepts and dimensional analysis, the Metric System, Density, Specific Heat and Specific Gravity, the division and the properties of matter, the atom and it's structures, the quantum theory, molecules and their behavior, periodic classification of elements, symbols, formulas, chemical equations, Stoichiometric calculations, the Gas Laws, and the concentration of solutions.

IV. COURSE OBJECTIVE

At the end of the course, the students should be able to:

A.COGNITIVE OBJECTIVES

1. Identify the over all goals of studying general and inorganic chemistry.
2. Define the different types of chemistry.
3. Solve problems on simple measurement and conversions.
4. Describe the different division and properties of matter.
5. Discover the importance and uses of matter.
6. Describe an atom and its parts.
7. Illustrate how atoms combine to form molecules.
8. List symbols of elements and compounds that participate in a chemical reaction.
9. Predict the products of a chemical reaction and the balance the chemical equation.
10. Determine the factors that affect the rates of chemical reactions.
11. Determine the factors that affect the rates of chemical reactions.
12. Calculate the Stoichiometric problems and equation.
13. Distinguish the different types of Gas Laws.
14. Prepare solutions of desired concentrations.

B. AFFECTIVE DOMAIN

1. Relate the importance of chemistry to the Engineering course.
2. Apply the importance of chemistry in day to day life.
3. Appreciate the properties and uses of matter in the environment.
4. Practice the knowledge in the computations of simple problems and conversions in other related engineering related courses.
5. Follow the correct methods in combining atoms to form molecules, and elements to form compounds:
    a. Explain chemical reactions and equations.
    b. Participate actively in classroom discussions and other activities.
    c. Complete all requirements in the course.

C. PSYCHOMOTOR OBJECTIVES

1. Differentiate matter according to its physical and chemical properties.
2. Create the products of atoms and the elements combined.
3. Write complete and balanced chemical equation.
4. Solve problems illustrating mathematical computations of conversions, measurements, Stoichiometric calculations, Gas Laws and concentration of solutions.
5. Bring about desired changes and present undesired changes.

V. METHODOLOGY AND ACTIVITIES

The students are required to complete the following:
1. Scheduled quizzes and periodic examinations.
2. Assignments and other extra work activities.
3. Seat works and board works.
4. Projects in the form of illustration boards to be passed at the end of the term.

The following materials will be used for classroom instruction:
1. Visual aids (illustration boards, charts, periodic table and others)
2. Over- head projector
3. Slide projector
4. Other audio- visual equipment

VI. COURSE OUTLINE

CHAPTER	TOPIC	NO. OF HOURS
PRELIMS		
1	SCOPE OF CHEMISTRY Branches of Chemistry Measurement concepts and dimensional analysis Metric system, density, specific gravity and heat *Board work/Assignments/Quiz*	6
2	MATTER AND ITS CHANGES States of matter Classification of Matter Solutions Definition of terms Components of solutions Types of solutions Factors affecting solubility Concentration of solutions' Changes of Matter Laws of chemical changes *Quiz*	2
3	ATOMS AND ATOMIC STRUCTURES Dalton's Atomic Theory Subatomic Particles Planetary Concept of an Atom Electron Dot Symbols and Electronic Configuration Electron Arrangement Quantum Theory *Board work/Seatwork/Quiz*	5
MIDTERMS		
4	PERIODIC CLASSIFICATION OF ELEMENTS	1

5	CHEMICAL BONDING AND FORMULA WRITING Ionic and Covalent Bond Common Ions and Their Oxidation States Formula of a Compound *Assignments/Board work/Quiz*	4
6	NAMING OF COMPOUNDS Major Classes of Compounds Naming Different Types of Compounds *Graded Recitation/Quiz*	4
7	CHEMICAL EQUATIONS Parts of a Chemical Equation Balancing Equations by Inspection, REDOX Balancing Equations in Ionic Form *Board work/Quiz/Assignments*	4
FINALS		
8	WEIGHT RELATIONS IN CHEMISTRY Atomic Mass and Atomic Weight Atomic Weight and Gram Atomic Weight Molecular Weight and Gram-Molecular Weight The General Mole Concept	4
9	STOICHIOMETRY Mole-Mole Calculations Mole-Ratio Method Limiting and Excess Reactant *Quiz/Assignment*	4
10	THE GAS LAWS Measuring Pressure of Gases Boyle's Law Measuring Temperature of Gases Charles' Law The General Gas Law The Ideal Gas Equation *Seatwork/Quiz/Assignments*	5

11	INTRODUCTION TO ORGANIC CHEMISTRY	3
OTHERS	ALLOWANCE FOR EXAMINATIONS	8
	Total number of hours	50

VII. TEXTBOOK

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APPENDIX B

PERMISSION TO FLOAT QUESTIONNAIRE

Benguet State University
Graduate School
La Trinidad, Benguet

August 2005

Engr. Conrado C. Rotor, Jr.
Assistant Dean, College of Engineering
University of Baguio

Sir:

The undersigned is conducting a study entitled "Factors Affecting Misconceptions in General Inorganic Chemistry" in partial fulfillment of the requirements for the degree of Master of Arts in Chemistry at the Benguet State University.

In this regard, may I seek permission from your office to administer survey questionnaires to your students who are presently enrolled in ENGCHM 1.

This researcher shall appreciate very much your prompt considerations.

Thank you very much and God bless.

Respectfully,

(Sgd.) Nimfa P. Del Rosario
Researcher

NOTED BY:

(Sgd.) Louisa P. Pladio
Adviser

APPENDIX C

SURVEY QUESTIONNAIRE

Dear Student,

This questionnaire aims to identify common misconceptions that may incur in your General Inorganic Chemistry course. Please put a check mark on the box provided on the item that best describes you. All information shall be kept highly confidential. Thank you very much for your cooperation and God bless.

Respectfully,

Nimfa P. Del Rosario
Researcher

Part A – Profile of Respondents

Name: (Optional) _____ ID No.: _____

Ethnic Background: _____ Gender: □ Male □ Female

High school academic rating in chemistry:

□ Below 75 □ 85 - 89
□ 75 -79 □ 90 - 94
□ 80 – 84 □ 95 and above

Parent's Highest Educational Attainment

□ Elementary level □ College graduate
□ Elementary graduate □ With Master's Units
□ High school level □ Master's Degree Holder
□ High school graduate □ With Doctoral Units
□ College level □ Doctoral Degree Holder

PART B. MISCONCEPTION DETERMINANTS IN GENERAL INORGANIC CHEMISTRY

(Arizona State University, 2001)

DIRECTIONS: Below is a list of some basic concepts in General Inorganic Chemistry. Indicate if the statement is true or false by putting a check on the space provided for. Please don't leave any item unanswered.

LEGEND: T – True, F – False

A. BASIC PHYSICAL CONCEPTS AND MATTER

		T	F
1.	The primary aim of chemistry is the accumulation of facts.	☐	☐
2.	Chemistry deals with artificial substances (chemicals) which are harmful and cause pollution.	☐	☐
3.	Chemical knowledge is truth.	☐	☐
4.	Chemistry is or should be concerned primarily with solving practical problems.	☐	☐
5.	A small steel paperclip floats better than a large steel paperclip.	☐	☐
6.	Air has no mass.	☐	☐
7.	Air is different from other gases; it resembles other invisible quantities such as energy, heat, and gravity.	☐	☐
8.	A kilogram of iron nails weighs more than a kilogram of water.	☐	☐
9.	Temperature is a measure of a body's heat.	☐	☐
10.	Temperature is a property of the material from which a body is made.	☐	☐
11.	Two objects sitting in the same environment for a long time reach the same temperature.	☐	☐
12.	Heating a body does not always mean raising its temperature.	☐	☐

		T	F
13.	When the form of an object changes, its weight or mass changes.	☐	☐
14.	The products of chemical actions need not have the same mass as the reactants.	☐	☐
15.	Water from melting ice is different from running water.	☐	☐
16.	Melting and dissolving are the same thing.	☐	☐
17.	Mass is conserved but not the number or species of atoms.	☐	☐
18.	Water disappears as it boils.	☐	☐
19.	When butter melts, water is formed.	☐	☐
20.	Bubbles from boiling water consist of air and oxygen.	☐	☐

B. CHEMICAL REACTIONS

1.	Chemical reactions are reactions which produce irreversible changes.	☐	☐
2.	Chemical reactions are caused by mixing of substances.	☐	☐
3.	Chemical reactions will continue until all reactants are exhausted.	☐	☐
4.	Chemical reactions must be driven by external intervention, for example, heat.	☐	☐
5.	Breaking chemical bonds release energy.	☐	☐
6.	Ionic pairs, such as Na^{+1} and Cl^{-1}, are molecular.	☐	☐
7.	The chemical bond is made of matter.	☐	☐
8.	Freezing and boiling are examples of chemical reactions.	☐	☐
9.	Physical and chemical changes are both reversible.	☐	☐

		T	F
10.	In a chemical reaction, the original substances or reactants, disappear completely.	☐	☐
11.	In a chemical reaction, atoms are also conserved.	☐	☐
12.	Adding salt to water decreases the amount of cooking time.	☐	☐
13.	Energy is used up and created during chemical reactions.	☐	☐
14.	Chemical reactions that proceed more rapidly also proceed more completely.	☐	☐
15.	If a reaction includes oxygen, it is an oxidation reaction.	☐	☐
16.	Substances containing H are acidic; substances containing OH are basic.	☐	☐
17.	A weak acid cannot perform as well as a strong acid.	☐	☐
18.	Strength of acids and bases and concentration mean the same thing.	☐	☐
19.	A weak acid cannot perform as well as a strong acid.	☐	☐
20.	When acids and bases are mixed, they do not react; they form a physical mixture.	☐	☐

PART C. ATTITUDE SURVEY TOWARDS CHEMISTRY

(Hand, 1953)

DIRECTIONS: Below is a list of statements that may describe your feeling towards Chemistry subjects. Please indicate by putting a check below the number that corresponds to your response.

THE CHOICES YOU MAKE WILL IN NO WAY AFFECT YOUR GRADE IN ANY SUBJECT.

LEGEND: 5-Strongly Agree, 4-Agree, 3-Moderately Agree, 2-Disagree,
1-Strongly Disagree

	5	4	3	2	1
1. This subject should be considered one of the most valuable subjects offered here.	□	□	□	□	□
2. The material covered by this subject is uninteresting.	□	□	□	□	□
3. Only about 10% of the students enjoy this subject.	□	□	□	□	□
4. This subject is an important part of the educational system in this university.	□	□	□	□	□
5. A passing grade on the final examination should be the only requirement for this subject.	□	□	□	□	□
6. Usually, I enjoy studying the lesson assignments of this subject.	□	□	□	□	□
7. There is a definite need for this subject in the campus.	□	□	□	□	□
8. This subject has its defects but is still worthwhile.	□	□	□	□	□

	5	4	3	2	1
9. The students do not remember the information they obtain from this subject.	□	□	□	□	□
10. This subject helps prepare the student to face the problems of everyday life.	□	□	□	□	□
11. I shall be able to use the information obtained from this subject at various times during my college career.	□	□	□	□	□
12. This subject is not worth the time and effort it requires.	□	□	□	□	□
13. I believe that a subject of this type is needed by all college students.	□	□	□	□	□
14. I feel that all new students should be required to take this subject.	□	□	□	□	□
15. Even though I fail to appreciate it, this subject maybe an important part of my education.	□	□	□	□	□
16. After graduation from college, the information obtained from this subject will be valuable.	□	□	□	□	□
17. After studying this subject, I shall be able to enjoy life more fully.	□	□	□	□	□
18. The basic principles of this subject are old-fashioned.	□	□	□	□	□
19. The amount of value information derived from this subject is very large.	□	□	□	□	□
20. I am inspired by this subject to make full use of my capabilities.	□	□	□	□	□

APPENDIX D

PROFILE OF RESPONDENTS

	ID #	ETHNIC	HSGRADE	PAREDUC	SCORE	CHFINAL
1	Bayang	KANK	77	HS GRAD	16	75
2	50181	TAGA	87	COLL LEV	27	88
3	47354	ILOC	81	COLL LEV	19	83
4	49544	BONT	81	W/ MA UNITS	17	82
5	48268	KANK	78	COLL LEV	19	75
6	42513	IBAL	82	HS LEV	29	78
7	48190	ILOC	85	HS GRAD	15	70
8	48093	ILOC	77	HS GRAD	11	70
9	48581	TAGA	75	W/ MA UNITS	19	94
10	36094	TAGA	89	COLL LEV	14	87
11	43737	TAGA	84	ELEM LEV	18	75
12	49240	ILOC	87	HS GRAD	14	79
13	49868	TAGA	75	HS GRAD	18	70
14	47504	TAGA	82	COLL GRAD	12	76
15	50737	TAGA	80	COLL LEV	13	75
16	49745	IFUG	78	COLL LEV	17	83
17	47940	ILOC	75	COLL GRAD	18	70
18	50582	IFUG	86	COLL GRAD	24	79
19	42625	KANK	77	HS LEV	13	70
20	51079	ILOC	75	ELEM LEV	13	70
21	35923	TAGA	79	COLL LEV	16	93
22	48669	TAGA	80	COLL LEV	15	75
23	47604	ILOC	88	COLL GRAD	31	70
24	48481	IBAL	80	HS LEV	15	76
25	49368	ILOC	90	COLL GRAD	22	88
26	48346	TAGA	84	HS GRAD	22	88
27	47396	TAGA	83	ELEM LEV	20	94
28	48561	BONT	84	COLL LEV	15	93
29	49734	ILOC	81	HS GRAD	15	77
30	48427	ILOC	84	HS GRAD	17	70
31	27917	TAGA	85	COLL LEV	14	75
32	Calinao	ILOC	95	HS GRAD	20	97
33	50709	KANK	75	ELEM GRAD	18	70

34	47891	ILOC	84	COLL GRAD	20	70
35	50576	ILOC	75	HS GRAD	20	70
36	48002	TAGA	79	COLL GRAD	16	70
37	43487	ILOC	75	HS GRAD	18	70
38	49741	ILOC	77	COLL LEV	12	70
39	48174	ILOC	79	COLL LEV	22	70
40	42548	TAGA	79	COLL LEV	20	79
41	47836	ILOC	75	COLL GRAD	15	70
42	49467	ILOC	81	COLL GRAD	16	70
43	49466	ILOC	80	COLL LEV	18	70
44	50611	IBAL	81	COLL LEV	5	75
45	49577	ILOC	78	COLL LEV	9	70
46	48911	ILOC	76	COLL GRAD	14	70
47	49998	ILOC	76	HS GRAD	22	75
48	47410	PANG	80	COLL GRAD	17	80
49	50048	ILOC	76	HS GRAD	13	70
50	51494	ILOC	85	HS GRAD	13	76
51	40581	KALI	83	MASTER'S	17	75
52	51459	KANK	87	ELEM LEV	17	81
53	51796	ILOC	77	COLL LEV	24	75
54	37469	ILOC	80	MASTER'S	19	75
55	50364	KANK	79	HS GRAD	17	84
56	45178	KANK	77	COLL GRAD	9	77
57	51598	KANK	75	COLL GRAD	14	70
58	51295	ILOC	75	COLL LEV	18	70
59	51014	PANG	77	COLL LEV	17	75
60	51818	TAGA	77	COLL GRAD	19	75
61	50688	ILOC	75	COLL GRAD	9	70
62	51172	ILOC	85	COLL GRAD	15	70
63	50945	TAGA	80	HS GRAD	16	76
64	50409	ILOC	79	COLL GRAD	10	75
65	41442	ILOC	86	COLL GRAD	13	83
66	51669	KALI	87	COLL LEV	15	75
67	50510	KANK	75	HS LEV	23	75
68	50919	ILOC	79	COLL GRAD	18	79
69	20132929	TAGA	85	COLL GRAD	19	76
70	44582	IBAL	75	HS GRAD	18	70
71	35009	KALI	84	HS GRAD	14	77
72	51789	ILOC	85	HS LEV	21	77
73	50970	TAGA	81	COLL LEV	21	79

74	45469	KALI	75	COLL GRAD	16	75
75	50246	TAGA	76	ELEM LEV	14	80
76	49530	KALI	87	COLL GRAD	15	80
77	38553	KANK	75	ELEM LEV	19	75
78	99302574	KANK	78	COLL LEV	23	75
79	50093	KALI	77	ELEM LEV	11	76
80	Baccangen	KANK	79	COLL GRAD	18	83
81	50914	IBAL	80	ELEM LEV	17	83
82	51344	ILOC	84	ELEM GRAD	16	86
83	47639	TAGA	79	COLL GRAD	11	70
84	50519	BISA	75	HS LEV	14	70
85	47380	IBAL	75	COLL GRAD	20	75
86	52110	PAMP	86	COLL LEV	12	84
87	48966	ILOC	79	COLL LEV	9	70
88	50950	ILOC	77	ELEM LEV	26	76
89	42558	ILOC	75	COLL LEV	18	70
90	49591	KALI	79	COLL LEV	13	75
91	51780	PANG	79	COLL LEV	13	75
92	49574	ILOC	93	COLL LEV	13	79
93	50987	ILOC	80	COLL LEV	9	75
94	51523	KANK	75	HS GRAD	12	76
95	49345	BONT	81	HS GRAD	11	75
96	50228	ILOC	76	COLL GRAD	14	70
97	51722	BISA	79	COLL GRAD	16	79
98	51802	ILOC	79	COLL GRAD	19	70
99	47654	ITNEG	78	MASTER'S	22	70
100	34858	TAGA	81	COLL GRAD	17	70
101	48070	ILOC	85	COLL LEV	15	70
102	48965	KANK	80	COLL LEV	18	70
103	48882	IBAL	76	HS LEV	16	70
104	50061	PANG	77	COLL LEV	13	70
105	20020802	TAGA	73	COLL LEV	20	70
106	49637	ILOC	90	COLL LEV	11	80
107	48627	ILOC	77	HS LEV	10	70
108	47869	PANG	80	COLL GRAD	22	75
109	49619	ILOC	83	COLL LEV	15	75
110	48027	ILOC	83	COLL LEV	17	75
111	51401	ILOC	81	COLL GRAD	21	76
112	49069	KANK	77	HS GRAD	11	75
113	49643	KANK	78	COLL LEV	13	75

114	48058	PANG	78	COLL GRAD	18	70
115	20120320	KANK	86	COLL GRAD	17	75
116	49977	ILOC	75	W/ MA UNITS	13	75
117	49753	KANK	78	ELEM GRAD	21	75
118	48421	KANK	84	HS LEV	10	70
119	49531	TAGA	81	COLL GRAD	19	75
120	48519	KANK	75	COLL GRAD	15	70
121	48413	KANK	79	HS LEV	32	75
122	49819	KANK	84	HS LEV	26	89
123	49790	KANK	90	COLL GRAD	16	81
124	49311	KANK	78	ELEM GRAD	14	84
125	49994	TAGA	86	COLL LEV	19	82
126	48663	ILOC	88	COLL GRAD	22	95
127	47780	TAGA	96	HS GRAD	21	92
128	48054	ILOC	78	COLL GRAD	11	70
129	49798	ILOC	75	COLL GRAD	21	70
130		IBAL	83	HS GRAD	17	82
131	50852	KANK	76	W/ MA UNITS	12	75
132	*****	KANK			13	*****
133	Abas	ILOC	75	COLL LEV	21	75
134	Nonog	ILOC	82	HS GRAD	20	80
135	Daniel	ILOC	84	COLL GRAD	13	97
136	43594	BONT	83	ELEM LEV	16	75
137	Ejercito	ILOC	75	HS LEV	19	78
138	Halog	ILOC	83	COLL GRAD	11	80
139	20033294	ILOC	86	COLL LEV	21	87
140	Molintas	IBAL	86	HS GRAD	21	92
141	*****	ILOC	85-89	HS GRAD	18	*****
142	50044	BONT	80	COLL GRAD	18	76
143	Taytayan	ILOC	85	COLL GRAD	15	89

APPENDIX E

Distribution of Responses: Misconceptions

Basic Fundamental Concepts and Matter

case	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Misc
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4	0	1	0	0	0	1	1	0	0	1	1	1	0	0	1	1	1	1	1	0	9
5	1	0	1	0	0	1	0	1	0	1	1	1	0	1	0	0	1	0	1	0	10
6	1	1	0	1	0	0	0	1	0	1	0	1	1	1	0	1	0	1	1	1	8
7	1	0	0	0	0	1	0	0	0	1	1	1	0	1	0	0	0	1	0	1	12
8	1	1	0	0	1	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	13
9	0	1	0	0	0	1	0	1	1	1	0	0	0	1	1	1	0	1	1	0	10
10	1	0	0	0	0	0	0	1	0	1	1	1	0	0	1	1	1	0	1	0	11
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131	1	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	14
132	1	0	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	14
133	1	1	0	0	1	1	1	1	0	1	0	1	0	0	1	1	1	1	1	0	7
134	1	0	0	0	0	1	1	1	1	0	1	1	1	0	1	1	0	0	1	1	8
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137	1	0	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	1	1	0	11
138	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	15
139	1	1	0	0	1	1	0	1	0	0	1	1	1	1	1	0	0	1	1	0	8
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141	1	0	0	0	0	1	0	1	1	0	1	0	0	1	0	1	1	1	1	0	10
142	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	0	0	1	1	7
143	1	0	0	0	0	1	1	1	1	1	0	1	1	1	0	1	0	1	1	0	8
SUM	112	69	10	23	67	91	48	107	46	73	82	63	53	71	80	96	46	61	93	29	
Misc	31	74	133	120	76	52	95	36	97	70	61	80	90	72	63	47	97	82	50	114	

Chemical Reactions

case	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Misc
1	0	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	15
2	1	0	1	0	1	0	0	1	1	0	1	1	0	1	0	1	1	1	1	1	7
3	0	1	0	0	0	1	1	0	0	0	0	0	1	0	1	1	1	1	1	1	10
4	0	0	0	0	0	0	1	1	0	1	1	0	1	0	1	0	0	0	0	0	14
5	1	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	1	0	1	0	12
6	1	1	1	0	0	1	0	1	0	1	0	0	0	1	1	0	1	0	1	0	10
7	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1	0	1	13
8	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	15
9	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	1	1	1	1	12
10	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	0	14
11	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	1	1	1	1	1	12
12	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0	1	0	1	0	0	13
13	1	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	1	1	1	0	11
14	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	1	1	0	14
15	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	15
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17	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	16
18	0	1	0	1	1	0	1	1	1	0	1	0	0	0	0	1	0	1	0	1	10
19	0	1	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	1	13
20	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	1	1	1	0	14
21	0	0	1	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	1	13
22	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	0	14

23	1	0	0	0	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	6
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83	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	16
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SUM	36	26	46	26	33	46	41	67	61	76	100	59	40	46	36	57	66	76	67	60	
Misc	107	117	97	117	110	97	102	76	82	67	43	84	103	97	107	86	77	67	76	83	

APPENDIX F

ATTITUDE SURVEY: DISTRIBUTION OF RESPONSES

	ID #	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20	sum
1		4	4	4	3	3	4	4	3	1	4	4	4	3	3	3	4	4	3	3	4	69
2	50181	5	5	3	3	3	4	4	4	3	5	5	4	5	3	4	3	3	4	3	4	77
3	47354	5	4	4	3	4	5	4	5	4	5	3	2	4	4	5	4	5	4	4	5	83
4	49544	5	2	3	5	4	5	5	5	3	5	5	2	4	3	4	3	3	3	3	4	76
5	48268	4	3	3	4	3	5	5	4	4	4	4	4	5	4	4	5	3	5	4	5	82
6	42513	3	4	2	4	3	5	5	4	3	2	2	4	3	4	3	4	3	5	4	2	69
7	48190	1	2	1	3	5	4	1	5	3	2	1	5	2	1	1	2	2	2	5	1	49
8	48093	4	2	3	4	3	5	5	1	3	5	3	3	3	3	4	4	2	3	3	3	66
9	48581	4	1	2	4	4	4	4	4	2	4	4	1	4	4	4	4	4	4	4	5	71
10	36094	5	1	3	5	1	5	4	5	1	5	5	1	5	5	5	5	5	3	5	5	79
11	43737	5	2	3	4	3	3	4	3	3	4	4	2	3	3	5	5	4	3	3	3	69
12	49240	5	2	2	4	4	4	4	3	3	4	5	2	5	5	5	5	5	3	3	4	77
13	49868	4	2	4	3	4	4	3	3	5	5	4	5	5	5	4	4	2	4	5	4	79
14	47504	1	1	5	2	3	3	4	3	2	3	3	2	4	3	3	2	3	4	3	3	57
15	50737	4	4	5	5	3	5	4	3	4	5	5	4	5	5	5	4	5	5	4	5	89
16	49745	3	2	2	4	3	4	3	4	1	4	5	2	5	5	5	5	2	4	5	5	73
17	47940	4	1	1	4	4	4	3	4	3	3	3	3	4	4	5	4	4	1	1	5	65
18	50582	4	2	3	4	3	3	3	3	5	3	5	3	3	3	4	5	4	2	4	3	69
19	42625	4	2	2	5	4	4	4	4	3	4	4	4	5	4	4	4	4	3	4	4	76
20	51079	4	3	3	4	4	5	4	4	3	3	4	4	4	5	5	4	5	3	4	4	79
21	35923	5	2	2	5	1	3	3	3	2	5	5	4	5	5	4	5	4	2	5	5	75
22	48669	4	2	1	3	4	4	3	4	2	4	5	1	5	4	5	3	5	3	5	5	72
23	47604	4	2	3	4	2	3	3	3	3	3	3	2	4	3	4	3	3	3	3	4	62
24	48481	5	2	3	5	2	3	4	4	3	5	5	2	5	5	5	4	4	4	5	5	80
25	49368	5	1	4	5	1	5	3	3	1	5	4	1	5	5	3	5	4	1	5	4	70
26	48346	5	3	3	4	3	5	4	5	4	5	4	3	5	5	5	4	4	2	4	4	81
27	47396	5	2	3	4	2	4	5	2	2	3	4	1	3	3	4	5	4	2	4	4	66
28	48561	5	2	2	5	2	5	3	2	4	3	4	3	5	4	4	5	4	2	5	3	72
29	49734	3	3	4	3	1	3	2	2	4	3	4	3	4	4	4	4	4	4	4	4	67
30	48427	4	1	3	4	4	3	2	3	3	4	5	1	4	4	3	5	3	3	3	3	65
31	27917	3	4	1	4	5	4	4	3	2	3	4	3	4	4	5	3	4	3	4	5	72
32		5	1	2	5	1	5	3	3	3	5	2	4	5	5	5	5	5	2	4	5	73
33	50709	4	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	59
34	47891	5	4	1	4	3	4	4	4	4	4	4	4	4	4	4	3	4	3	4	4	75
35	50576	5	2	2	4	2	4	3	3	2	4	4	2	5	5	5	5	4	3	4	4	72
36	48002	4	3	4	4	5	4	3	3	4	5	3	2	4	4	5	3	3	3	4	4	74
37	43487	4	1	3	5	2	4	4	4	4	5	3	5	4	3	5	5	5	3	4	5	78
38	49741	4	3	2	5	4	4	3	4	3	4	5	3	5	5	5	5	5	3	4	5	81
39	48174	5	2	2	5	3	5	5	4	3	5	5	2	5	5	5	5	5	2	5	5	83
40	42548	4	2	3	5	2	3	4	4	2	3	5	2	4	4	4	4	4	2	4	3	68
41	47836	3	2	3	4	3	2	4	3	3	3	5	4	4	4	3	5	2	4	4	4	69
42	49467	5	2	3	5	1	4	2	4	4	3	3	1	4	4	4	4	4	2	4	3	66
43	49466	5	1	1	5	3	4	4	4	4	5	4	2	3	3	4	4	3	3	4	4	70
44	50611	3	2	3	5	2	3	3	3	3	3	3	3	4	2	4	3	3	3	3	3	61
45	49577	5	4	5	3	4	5	4	3	4	3	5	4	5	5	5	5	5	5	5	5	89

46	48911	3	4	2	5	3	4	4	4	2	5	4	3	5	5	4	4	5	2	3	3	74
47	49998	4	1	2	4	1	3	5	2	1	5	4	2	4	5	4	4	5	2	3	5	66
48	47410	5	1	3	5	1	4	4	3	3	3	5	2	4	5	5	4	4	4	5	4	74
49	50048	3	2	4	4	3	2	3	4	3	2	4	2	4	4	5	3	3	3	4	4	66
50	51494	5	1	3	4	3	3	3	4	3	4	4	1	3	3	5	4	4	3	4	5	69
51	40581	5	1	3	5	4	4	5	4	5	5	3	3	3	3	4	3	3	2	4	3	72
52	51459	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	80
53	51796	4	3	4	3	4	3	4	4	1	1	2	2	2	2	3	3	5	5	3	3	61
54	37469	4	1	3	5	1	4	4	4	3	4	5	2	5	5	5	5	5	4	5	4	78
55	50364	4	3	3	4	3	4	3	4	3	4	3	3	4	4	4	4	4	3	4	4	72
56	45178	4	2	3	5	2	3	3	3	3	4	3	3	3	4	4	4	4	3	3	4	67
57	51598	4	1	2	4	1	5	4	1	2	5	5	1	5	5	5	5	5	1	5	5	71
58	51295	3	2	2	4	2	2	2	3	2	2	1	2	2	3	2	3	2	2	3	2	46
59	51014	4	3	5	4	3	3	4	4	3	3	4	4	4	4	4	4	4	3	4	4	75
60	51818	4	4	3	1	3	1	3	4	3	3	3	3	4	3	1	1	3	4	3	3	57
61	50688	5	2	2	4	3	3	3	3	2	3	3	2	3	2	2	3	4	4	3	3	59
62	51172	5	2	4	5	3	3	3	4	4	4	4	4	5	5	5	5	5	3	3	5	81
63	50945	5	2	2	5	2	5	5	5	3	5	5	5	5	5	5	5	5	5	5	5	89
64	50409	4	4	3	4	3	4	4	3	3	3	4	2	3	3	3	3	4	3	3	4	67
65	41442	5	1	1	2	3	5	3	4	2	5	5	4	5	3	3	4	5	4	3	4	71
66	51669	5	3	2	4	3	3	4	3	2	4	3	4	3	3	5	3	4	2	4	3	67
67	50510	3	2	4	4	2	3	2	5	1	5	4	4	4	4	4	4	4	2	3	5	69
68	50919	5	5	5	5	5	3	5	5	4	5	5	3	5	5	5	5	5	3	3	5	91
69	20132929	3	2	3	3	3	4	3	3	3	4	3	2	3	3	2	4	4	2	4	4	62
70	44582	5	4	2	4	4	3	4	3	4	4	4	4	2	3	5	5	4	4	5	3	76
71	35009	5	2	3	4	4	5	3	3	3	4	4	4	3	3	3	5	4	3	4	4	73
72	51789	5	1	2	4	1	3	3	4	3	5	4	2	5	3	5	5	5	3	4	5	72
73	50970	5	1	4	5	2	4	3	4	3	5	5	3	5	5	5	5	4	2	4	4	78
74	45469	4	2	4	5	4	4	3	2	5	4	3	4	3	4	2	4	3	4	2	3	69
75	50246	4	4	5	4	5	3	4	3	4	3	4	3	4	2	4	4	5	4	5	4	78
76	49530	5	1	2	5	2	5	3	3	2	5	5	3	5	3	5	5	3	2	5	5	74
77	38553	4	4	2	4	2	4	3	4	2	4	4	2	4	4	5	4	4	2	4	5	71
78	99302574	4	1	1	1	2	4	2	2	1	5	3	2	4	4	3	3	3	3	4	4	56
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81	50914	5	2	3	5	3	4	4	3	2	5	4	3	4	3	4	3	2	4	4	4	71
82	51344	5	1	3	5	1	4	4	4	4	5	5	1	5	5	5	5	5	2	5	5	79
83	47639	5	3	4	5	4	3	3	3	3	5	4	5	3	3	5	4	4	3	4	5	78
84	50519	3	4	3	4	3	3	4	4	2	4	3	4	3	5	3	3	2	4	2	4	67
85	47380	3	2	4	5	1	4	4	3	5	5	5	1	4	4	5	5	5	2	4	5	76
86	52110	5	4	4	5	4	5	4	5	4	5	5	4	5	4	5	4	5	4	5	4	90
87	48966	5	4	3	4	2	4	3	4	5	3	5	4	3	3	4	3	4	4	4	3	74
88	50950	3	2	3	5	3	3	3	4	3	3	3	2	4	4	4	3	3	3	3	3	64
89	42558	4	2	3	3	1	2	1	3	2	2	2	3	3	3	2	3	2	2	3	3	49
90	49591	4	3	4	2	4	3	4	4	4	4	4	3	4	4	4	4	4	4	3	4	74
91	51780	4	5	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	2	63
92	49574	5	1	2	5	1	4	4	2	2	4	5	2	5	5	5	5	4	4	4	4	73
93	50987	5	1	2	5	1	4	4	3	4	3	5	2	5	5	5	5	5	4	4	4	76
94	51523	5	1	3	4	5	4	4	4	3	4	5	4	4	5	5	4	4	2	3	4	77
95	49345	3	3	2	3	2	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3	56
96	50228	5	1	2	5	5	5	4	3	2	5	5	1	5	5	1	5	5	1	5	5	75
97	51722	4	2	4	4	1	4	4	4	2	4	4	2	4	4	4	4	4	2	4	4	69
98	51802	4	2	3	2	3	3	3	3	3	4	4	2	4	3	4	4	5	2	5	4	67
99	47654	4	2	3	4	3	3	4	4	2	5	5	4	4	3	5	5	5	2	4	4	75
100	34858	3	4	2	3	4	2	2	3	4	2	4	2	2	2	4	2	2	4	4	4	59

101	48070	5	1	2	1	1	5	5	4	1	5	5	1	5	5	2	5	5	2	5	5	70
102	48965	5	2	3	1	3	4	3	2	3	4	4	2	4	4	4	5	5	3	3	5	69
103	48882	4	1	2	5	3	4	5	3	3	4	4	3	4	5	4	3	4	3	2	4	70
104	50061	3	4	2	5	3	3	3	4	3	5	4	2	3	3	3	4	3	3	3	4	67
105	20020802	3	3	5	5	5	2	2	3	3	2	4	3	2	2	4	3	2	3	2	3	61
106	49637	4	2	3	4	2	3	3	4	3	2	4	2	3	4	4	4	4	3	3	4	65
107	48627	3	4	2	5	2	5	3	2	1	5	5	3	5	5	1	4	5	4	3	4	71
108	47869	4	2	1	5	4	4	4	4	2	5	4	2	5	5	5	4	4	2	3	4	73
109	49619	5	4	3	5	3	3	5	4	3	5	5	1	5	3	5	5	5	3	5	5	82
110	48027	5	3	3	5	5	4	5	5	4	5	5	5	5	5	5	5	5	4	5	5	93
111	51401	3	1	3	5	5	3	3	3	1	3	5	1	5	5	4	5	5	1	5	5	71
112	49069	5	3	2	2	4	4	5	3	4	5	5	3	4	4	4	4	4	3	4	4	76
113	49643	4	2	4	4	2	2	2	4	4	4	4	3	4	4	5	5	4	2	3	3	69
114	48058	4	3	2	5	2	5	3	4	2	5	5	2	5	5	3	3	4	3	4	3	72
115	20120320	5	4	4	5	4	3	2	1	3	4	4	3	4	4	4	4	4	1	4	4	71
116	49977	4	3	3	4	4	4	3	3	3	4	3	3	4	4	3	4	4	2	3	4	69
117	49753	5	5	3	5	1	3	5	5	3	5	5	1	5	5	5	5	5	3	5	5	84
118	48421	5	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	5	81
119	49531	4	2	2	4	3	4	4	3	3	4	4	2	5	5	5	5	4	2	4	4	73
120	48519	3	2	4	2	2	4	3	4	1	3	5	4	3	3	4	5	3	1	5	3	64
121	48413	3	2	2	4	2	3	3	2	2	3	3	3	3	4	5	4	4	2	4	3	61
122	49819	4	2	3	4	2	2	3	3	3	4	4	2	4	3	4	4	3	2	3	2	61
123	49790	4	2	1	5	2	4	3	3	2	2	5	4	5	5	5	5	5	3	2	2	69
124	49311	5	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5	5	4	5	5	97
125	49994	5	1	1	5	2	4	4	3	4	4	3	4	3	4	4	4	5	3	4	4	71
126	48663	5	2	3	4	2	3	3	4	2	4	4	3	5	3	4	5	4	2	4	4	70
127	47780	5	1	2	5	1	5	3	2	1	5	4	1	3	3	5	5	3	3	5	5	67
128	48054	4	3	5	2	3	4	3	2	3	2	4	3	5	3	5	5	3	2	1	4	66
129	49798	5	1	2	5	1	5	2	3	3	5	5	3	5	5	5	5	5	2	2	5	74
130		5	4	4	5	1	3	4	4	3	5	4	2	4	4	4	4	4	2	4	4	74
131	50852	3	3	3	3	2	3	4	5	4	4	3	3	3	2	5	4	3	3	3	3	66
132	*****	5	1	3	5	1	5	5	5	3	5	4	1	5	3	5	5	5	2	5	5	78
133		4	4	3	4	2	3	3	3	3	2	3	4	4	4	3	3	3	3	4	4	66
134		5	1	1	5	5	4	3	2	3	5	5	4	5	3	5	5	4	2	3	3	73
135		4	2	3	5	4	4	4	5	3	3	5	4	4	3	4	4	3	4	5	3	76
136	43594	5	5	1	5	2	2	5	2	2	5	5	1	5	5	5	5	5	2	4	5	76
137		5	4	3	3	2	4	3	3	3	4	4	4	4	3	5	3	4	3	3	5	72
138		5	4	5	5	5	4	4	5	4	5	5	4	3	4	4	4	5	5	4	5	89
139	20033294	5	2	3	4	3	4	4	4	3	5	4	3	4	4	3	4	4	3	4	4	74
140		5	2	3	4	1	4	4	3	4	5	4	2	5	5	4	4	5	2	4	4	74
141	*****	4	2	2	2	2	4	4	3	2	4	4	2	3	2	4	4	3	2	3	3	59
142	50044	5	4	3	4	2	1	3	3	4	3	3	3	3	3	3	2	3	3	3	3	61
143		3	2	2	3	2	3	4	2	4	3	4	2	4	3	5	5	4	4	5	4	68

APPENDIX G

TABLES

ANOVA of Moderator Variables

Variable	SS: Between Within Total	df: Between Within Total	Mean Square	F	Sig.
ETHNICITY	225.037 2596.794 2821.831	10 131 141	22.504 19.832	1.135	0.341
HSGRADE	106.015 2715.816 2821.831	5 136 141	21.203 19.969	1.062	0.384
PAREDUC	26.484 2795.346 2821.831	3 138 141	8.828 20.256	0.436	0.728
CHFINAL	185.796 2634.417 2820.213	5 35 140	37.159 19.514	1.904	0.098
SUMATT	50.872 2770.959 2821.831	4 137 141	12.718 20.226	0.629	0.643

BIOGRAPHICAL SKETCH

The researcher was born in Manila on June 4, 1960. She is the eldest among the five children of the late Bienvenido S. Pontines of Ozamis City, Misamis Occidental and the former Avelina F. Cardenas of Tondo, Manila.

She finished her elementary education at Immaculate Conception Parish School, Cubao, Quezon City and her secondary education at the University of Santo Tomas, Sampaloc, Manila. She obtained her Bachelor of Science in Chemical Engineering degree also at the University of Santo Tomas in 1981and passed the Licensure Examinations for Chemical Engineers in November, 1981.

She has over 15 years industrial job experience in various capacities, from laboratory aide in a food company to quality assurance manager of a machine tool manufacturer. She joined the academe in June 2000.

At present, she is a faculty member of the University of Baguio College of Engineering, Architecture, and Industrial Technology.

She is married to Jaime F. Del Rosario and is blessed with three children: Julia Noemi, Nolan Joshua, and Jillian Nina.