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Science and Mathematics Education Centre

Reconceptualizing a College Chemistry Course to Improve Teaching and Learning

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DEDICATION

This thesis is dedicated to my husband Emerson P. Gallos and children,
Harold Emerson, Joseph Ernest, Emma Ruth and Emmy Lou.
They have been the source of strength and
inspiration to complete this
work.

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ABSTRACT

This thesis describes the process of course and faculty development in college chemistry at the University of San Carlos in the Philippines. The aim of the research was to increase intellectual engagement through the implementation of a simple instructional cycle to replace a dominant lecture approach. The cycle consisted of three phases: (a) a plenary which is a short presentation of the subject matter, (b) seatwork activity where students work on problems, questions or activities with the instructor moving around the classroom, and (c) closure or summary which includes reactions to learning difficulties encountered by the instructor during phase b. The approach was designed to improve basic teaching skills and to enhance instructors' knowledge of student learning problems.

The research employed qualitative and quantitative methods utilising multiple sources of data collection. Validation and reliability criteria were addressed through pluralistic epistemologies; triangulation, use of external observers, member checks, peer commentaries, and case studies. Likewise, the instructors' adaptation to the three phases in the approach were analysed together with students' perceptions of the teaching approaches in the new course.

Two instructors, who were involved in the case study, taught the first version of the course having been coached by the researcher who attended almost all lessons within the semester. Analysis of the data indicated that the instructors developed teaching skills applicable in this instructional cycle approach. Problems in the implementation of the cycle were identified and used as the basis for the reconceptualization of a year-long, departmental study involving 13 instructors each of whom applied the instructional cycle to some degree. Three instructors were able to significantly change their teaching and apply meaningful student seatwork in their lessons. Nine instructors, who were moderately successful implementers, exhibited some pedagogical growth but still had problems in maintaining a well-organised classroom environment. The other three instructors had considerable trouble in applying the new approach.

The shift from lecturing to applying the instructional cycle might seem like a relatively small change, yet it is a huge step for instructors who have predominantly taught using lectures for over ten years. This situation called for support by effective intervention through a realistic and practical faculty development program. After an initial training of instructors, extensive coaching in the classroom was used during the implementation phase as well as weekly small group meetings and monthly large group seminars. The course and faculty development process led to a strong increase in chemistry and chemistry pedagogy discussions in the faculty room with increasing collegiality. After the initial implementation, the process of change has continued. Every semester more improvements are made and several other Chemistry courses have been revised using the instructional cycle model of instruction.

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CHAPTER I
INTRODUCTION

1.0 The Need for More Effective Teaching of Science

Effective teaching has been the concern and the subject in countless research investigations, symposia, meetings and conferences around the world, particularly in developing countries (Biggs, 1999; Burke & Walton, 2002; Galton & Eggleston, 1979; Kornhauser, 1979; Rosenshine, 1983; Rosenshine & Stevens, 1986; Troisi, 1983; Walberg, 1991). In this thesis in the field of science education, particularly chemistry education, research evidence on effective teaching approaches and behaviours of effective teachers is presented, discussed and debated. However, there are no straightforward answers found because teaching effectiveness is only meaningful when related to specified teaching and learning goals (Feiter, Vonk, & Akker, 1995). In addition, research findings on the effectiveness of science teaching are scarce for higher education, particularly in chemistry and certainly in developing countries (Feiter et al., 1995; Galton & Eggleston, 1979; Kornhauser, 1979).

A major problem in General Chemistry courses at college level is that the vast majority of undergraduate students often see the course as an insurmountable hurdle (Duchovic, 1998). Too often learning is merely the ability to repeat information found in textbooks or provided by the teachers. Such a view equates learning to remembering what one reads or has been told in a lecture. "The present way we teach undergraduate science at colleges and universities almost everywhere simply does not stimulate active learning" (Lord, 1994, p. 346). College chemistry teachers' views of teaching are based on assumptions and beliefs usually formed as a result of their earlier personal school experiences. In most cases, instruction occurred as transmission of knowledge rather than as a process of interaction and construction of knowledge (Craig, 1993; Spencer, 1999).

It is also widely recognized that lecture and algorithmic lower-order cognitive skills continue to dominate college chemistry instruction (Brandt, et.al., 2001; Furio, Azcona, Guisasola, & Ratcliffe, 2000; Garnett & Treagust, 1992a; Garnett & Treagust, 1992b; Griffiths & Preston, 1992; Zoller, Dori, & Lubesky, 2002). The same trend was noted in the university under investigation where students tend to memorize algorithms rather than learning the underlying concepts and considers different concepts as isolated elements of knowledge. Chemistry content is seen as a list of equations and factual information that could be memorized and reproduced during examinations. Even prospective teachers conceived chemistry learning as reproductive rather than constructive and chemistry teaching is viewed as facilitating reproductive learning (Aguirre, Haggerty & Linder, 1990; Marton, Beaty & Dall'Alba, 1993; Zoller, Dori, & Lubesky, 2002). This conception of the prospective science teachers opposes the expectations set forth by international science education community that learning science is a constructive endeavour and science teaching should facilitate this type of learning (Andersson, 2000; Duit, Treagust & Fraser, 1996; Rennie, Goodrum, & Hackling, 2001).

The lack of coherence of college students' knowledge of science is suspected to be the source of students' difficulties in concept formation and application, and proliferating misconceptions (Herron, 1996; Lee & Fensham, 1996). Furthermore, there is limited attention in science education for opportunities where students are explicitly taught the skill of synthesising knowledge (Morgan, 1995; Zoller, 2000). Those opportunities could enhance students' ability to integrate newly acquired concepts with prior knowledge.

According to Lord (1994) and Seymour (1995), college science courses are notorious for poor teaching. Most college-level teachers of chemistry proceed directly from an undergraduate and graduate degree program to the classroom without achieving any pedagogical training. Unfortunately, most teachers have little knowledge of different learning styles of students or classroom strategies and approaches that have been shown to produce effective environments for learning (Leonard, 1997). Most teach what they were taught in the same way they were taught; custom and tradition prevail with the emphasis on providing instruction rather than producing learning.

Educational researchers state that learners who are actively engaged in the learning process are the most successful (Dunkhase, 1997). Active teaching approaches, though complex and in many respects challenging, are judged by many science educators as the most effective (Caprio, 1997). Teaching within this framework emphasizes the importance of exploring students' initial understanding, encouraging a high level of responsibility for their own learning, and assisting them to learn how to learn. When carefully introduced into classrooms, active teaching methods help the teacher and students develop and consolidate both skills and understanding of the processes involved (Felder, 1996; Hatcher-Skeers & Aragon, 2002; Paulson, 1999).

However, work for the effectiveness in teaching science, development or improvement must be oriented to students' achievement (output) and classroom practices (process). Both the output and the process need to address basic elements in science teaching such as (a) efficient classroom use of textbooks, (b) optimum use of classroom time, (c) proper use of homework, and (d) systematic monitoring of students' progress by well balanced practices (Feiter et al., 1995; Walberg, 1991).

Berg (1996) suggests focusing on the improvement of conventional teaching approaches rather than aiming at more complex and sophisticated approaches. In this way, conventional teaching can become more interactive and meaningful through active learning strategies. However, there is still a need to pay ample attention to the kind of basic teaching skills that accompany effective conventional approaches. Improvement is most likely to occur when regular supervision, control of students' seatwork and a well-managed classroom are put in place and a strong foundation is laid for more complex kinds of instruction (Walberg, 1991). To put this approach into operation, it is best to think of the complimentary aspects of constructivist and conventional approaches rather than the conflicting ones and then work on practices where teachers become more competent and confident in those basic skills. Eventually, teachers become more capable of dealing with more complex goals and student-centred aspects of instruction.

In order to make science instruction more meaningful for learners, current literature suggests that new classroom processes need to shift from teacher-centred to student-centred pedagogy. The paradigm shift must emphasize (a) less rote learning and more learning for understanding, (b) less passive note taking and more varied, interactive and active learning strategies, (c) less transmission of abstract theory and more relation to the social context and to students' everyday life experiences, and (d) more attention to practical skills, process skills and problem solving (Feiter et al., 1995).

The current status and conditions of science education in the Philippines, in particular the University of San Carlos (USC), need ample attention to achieve a realistic, feasible, short and long-range perspective for improving science teaching.

1.1 Background and Rationale

The Philippines is an archipelago made up of about 7000 islands with a population of 80 million (Torrevillas, 2002). There are over 1400 tertiary-level institutions in the country; many are more like vocational schools or community colleges while others are full-fledged universities (Acedo, 2002). Elementary school education lasts six years and secondary school is only for four years; subsequently, students enter university after 10 years of general education rather than 12 years as in other countries like Australia and USA, excluding kindergarten. It must be noted that in the Philippines, colleges and universities offered baccalaureate degree courses thus the terms college and university are used interchangeably to indicate tertiary level education (Year 11-15) unlike in Australia and other western countries where colleges take care of the senior high schooling and only after finishing years 11 and 12 that a student could proceed to university studies. The set-up is different in the Philippines because the tertiary-level institutions (colleges and universities) provide the 11^{th} and 12^{th} grade education as part of the baccalaureate degree. Most baccalaureate degree programs last four years, some like Engineering take five years, and the tertiary-level enrolment rate is among the highest in the low-income countries. For this thesis the terms college and university have the same meaning.

However, the Philippine education system is not performing well. The current state of science as "assessed by a renowned Filipino scientists both in local and international circles is discouragingly poor" (Rivera & Ganaden, 2000, p. 25) and lugubrious (Bernardo, 1999). On the Third International Mathematics and Science Study (TIMSS) and the TIMSS-Repeat, the Philippines ranked third from the bottom on Science and Mathematics and quite far below neighbouring countries (Balce et al., 2000; Ibe & Ogena, 1998; Nebres, 1997). National tests show poor results as well and frequently even contain wrong questions. There are many reasons for this dismal performance. Poor teacher training, the overcrowded curriculum, the overloaded textbooks, the teaching-learning process, and the governance of education were pointed out as causes for the current state of science education in the country (Ibe & Ogena, 1998). Large and small scale programs, many of which are foreign-assisted projects, have been designed and implemented to reform science education in the country. However, the education system does not seem to reap the benefits from these programs (Bernardo, 1999).

The inadequate supply of qualified science teachers has contributed to the critical situation of science teaching; for example more than 90% of the secondary Physics teachers and 80% of the Chemistry teachers are not certified in their subject. Most of these teachers majored in other subjects and were then forced to teach Physics or Chemistry. A mismatch between a teacher's training and subject specialization with the classes handled commonly exists in most high schools (Nebres, 1997). The scarcity of science teachers and the fast growing population has led teachers to teach many and very large classes. Class sizes of 60 and even 70 are quite common in secondary schools whereas elsewhere in Asia the typical class size is 45 students per class.

In-service teacher-training programs, also known as INSET, rarely address the real needs of classroom teachers. Most INSET are one-time courses taught away from the school context. Both the INSET and the pre-service education have failed to meet the priority training needs of teachers: need for greater science subject content; specific pedagogic training applicable to the science subject they teach; knowledge and methods of student assessment and classroom management techniques (Acedo, 2002). The weak exposure of student teachers to actual classroom situations and the deficient in-service training have translated into ineffective teacher practices such as heavy emphasis on memory and recall rather than understanding; learning environments that elicit passive student behaviour; underdevelopment of student problem solving skills; lack of attention to individual learning needs; and under use of group methods to foster cooperative learning (Acedo, 2002).

The science curriculum is overcrowded (Berg, Alfafara, & Dalman, 1998) with too many subjects and too many lessons to cover with too little time. Teachers are unable to finish within the academic year a wide range of topics covered in the curriculum; even if they do, the teaching is largely focussed on knowledge and recall rather than the acquisition of higher order thinking skills (Ibe & Ogena, 1998). This over-loaded curriculum and large science classes provide little opportunity for concrete hands-on activities and investigations, (Yoshida, 1997); likewise subject-based student-student interactions are very limited.

Another issue involves textbooks. Overloaded textbooks cover too much content (Nebres, 1997) and "teachers tend to stay longer in topics which they are most comfortable with and skip topics which they do not know" (Talisayon cited in Ibe, 1998, p.22). Since the privatisation of the textbook market in the late 1980s, the quality of high school science books has deteriorated. The most recent crop of textbooks contains many errors and inaccuracies, wildly varying levels of difficulty throughout the text, illogical sequencing of concepts, a lack of proper conceptual explanations and relations to everyday phenomena (Berg, 2002). The result is that science becomes incomprehensible and must be memorized. Unfortunately many teachers are poorly trained and cannot find the textbook errors on their own. Before the privatisation of the textbook market, there were good books produced by publicly supported national writing teams with subsidized try-outs.

With regard to the actual teaching and learning in Philippine classrooms, Somerset, Alfafara, and Dalman (1999) observed 60 science and mathematics lessons in 15 private and public schools. The lessons certainly were much more interactive than college lessons and a few lessons were reported as being outstanding with a systematic build up of concepts and interaction that emphasized real understanding. However, in most lessons much of the interaction was superficial and was inadequate for developing conceptual understanding (Somerset, Alfafara, & Dalman, 1999). Although the lessons that Somerset observed were randomly picked from a school schedule, observation visits had been pre-announced and thus his team observed teaching with optimal preparation. Similar observations were reported in Bernardo (1998) and Reteracion (1996).

On the other hand, Berg et al. (1998) observed typical teaching in 60 lessons and followed biology and chemistry teachers in two high schools for three weeks in each school. A general pattern found was that each lesson consisted of dictation for 50% of the time followed by questions for another 50% of the time. Many teacher questions could be answered by just reading sentences from the dictation or from the textbook where books were used. In one extreme instance, every successive question had the next bold printed word in the book as an answer. Under these circumstances, students are unlikely to develop the prerequisite conceptual knowledge and study skills they need in college.

The management environment of the education system and schools does not strongly encourage teachers to perform, particularly in public schools. The large classes and inadequate facilities as well as the unqualified supervisors in science and mathematics (Ibe & Ogena, 1998) do not motivate but contribute to low morale in the science teaching profession. The actual incentive structure as applied within the schools does not disadvantage non-performing or lazy teachers nor does it reward good performance. The same can be said about school performance. Well-organized schools are not rewarded and poorly organized schools are not punished. In such an environment, new skills and methodologies learnt in in-service are usually only practiced when there are visitors.

Furthermore, common tests emphasize details over main principles. High stakes elementary or secondary national examinations do not exist; students' results on the National Elementary Achievement Test (NEAT) and on the National Secondary Achievement Test (NSAT) have no influence on whether or not students can graduate. These examinations have a record of poor test items which then become poor examples for teacher and school-made tests. Similar problems exist in higher education. At many colleges (although not at the University in this study) Physics and Chemistry courses are taught by lecturers who did not major in these subjects and if they are science majors many have a limited repertoire of pedagogical skills. While high school teachers mainly lecture and the majority has a transmission view of teaching and a cumulative-accretion-of-knowledge view of learning (Reteracion, 1996), college science instructors do the same, too. Class activities are predominantly teacher-centred and instructional resources like textbooks are also limited. Most college textbooks, particularly in chemistry, are international editions of American college textbooks. They are good quality but intended for students who had six rather than four years of secondary education.

At the University of San Carlos (USC), student achievement in the introductory chemistry courses in the Chemistry Department is unsatisfactory, with a substantial number of students failing every semester. Instructors are dissatisfied with the passiveness of the students and students find their chemistry classes dull, boring and teachers uninspiring (SAS, 2000; Teachers' Evaluation Report, 1992-99). Furthermore, students view their chemistry course as a required subject that they have no choice but to take and pass. Their perception is that their grades are in the hands of their teachers. The researcher's recent observations of nine classes and nine instructors of General Chemistry (Chapter 4) and the survey results conducted by the Philippine Association of Accredited Schools, Colleges and Universities (PAASCU, 1997, 2000) provided documentation of the situation with regards to the unsatisfactory results. Activities calling for active learning were inadequate to sustain the interest of students; likewise active classroom techniques were not evident.

The problems confronting the Chemistry Department of USC are students with low performance, superficial understanding, a lack of conceptual learning and a lack of motivation and interest. Likewise, instructors have a narrow repertoire of pedagogical skills, lack knowledge about student difficulties, have insufficient skill in distinguishing main principles from details and sequencing a good build-up of concepts. The most feasible and realistic way to address these problems is to restructure the course and add activities or exercises that would promote active engagement of students in and outside of the class. Instructors would then be trained on the job to attain a wider repertoire of teaching skills, particularly in guiding and monitoring students work. In turn, this guiding and monitoring of student work will likely lead to teacher learning of pedagogic content knowledge. Devising a path that considers the current situation of students and instructors in USC, particularly in the Chemistry Department, will lead towards improved teaching and learning; finally an ideal constructivist environment might be attained.

Considering Berg's suggestion stated earlier and the dismal classroom practices in college science courses necessitates the implementation of a course and teacher development program that is contextual, practical, relevant and sustainable enough to effect long-term changes in each teacher's behaviour. In addition, the researcher's own experience in various teacher training programs provided by the University were short-lived and had weak implementation that undermined teachers' enthusiasm and motivation. This situation resulted in teachers returning to the chalk and talk mode of instructional delivery. Dr. William Padolina, former secretary of the Department of Science and Technology, often stressed that the reason for unsuccessful reform efforts in science education is that the reforms are not being implemented in the scale and intensity that is required. The former secretary often states this as " We know the medicine that will solve our problem, but we cannot give this in the correct doses" (cited in Bernardo, 1999, p. 2).

It is in this context that an academic course and faculty development model with emphasis on basic teaching skills and a simple instructional cycle was conceived and implemented. The coaching approach to teacher development was employed because it has proven to be less costly, more effective and have long-lasting effects on modifying and changing the behaviours of teachers, resulting in improved classroom discourse and student learning (Showers & Joyce, 1996).

This study initiated the reconstruction of the first part of the General Chemistry course taught to freshmen (about 16-17 years old) engineering students enrolled at the University of San Carlos – a catholic private university in the southern Philippines. The General Chemistry course is divided in two parts. The first part has a course code name Chem 4 and the second part has a course code name Chem 14. Both Chem 4 and Chem 14 have laboratory component but are taught separately from the theory part. Chem 4, which includes content topics such as forms of matter, atomic structure, periodic table, chemical bonds, phases of matter, stoichiometry and basic concepts of thermochemistry, is taught in semester one while Chem. 14, which includes content topics like solutions, chemical kinetics, chemical equilibrium, electrochemistry and metallurgy is taught during semester two of each academic year. A university student is required to complete and pass Chem 4 before enrolling in Chem 14. The reconstruction process included the development of the theory part (known in USC as lecture) of Chem 4 course material used by the teachers and the training of these teachers while implementing the said course.

1.2 Objectives

The primary purpose of this study was to begin a process of course and teacher development in order to increase the mental effort of students in and outside the classroom and structure this process such that it results in considerable teacher learning. Specifically, the aim is to reconstruct the General Chemistry course (Chem 4) by applying a instructional cycle approach in which each class meeting consisted of one or more cycles of three phases: a) a plenary session involving a short presentation of new information, b) student work on problems, questions or activities with the instructor moving around the classroom, and c) a plenary summary which includes reactions to learning difficulties encountered by the teacher during phase b. The designed instructional cycle approach would enable the instructors to improve basic teaching skills and to enhance their knowledge of student learning difficulties and to maximize student intellectual engagement in the class.

Consequently, implementing a instructional cycle approach in teaching Chem 4 was intended to result in better learning by the students as well as helping them to be more involved in their own learning. Furthermore, this research investigated the effects of the instructional cycle approach on the classroom practices of the teachers and the performance of the students. The instructional cycle approach appears necessary because the students are used to lectures in their high school and teachers believe this mode has worked over many years. Added to this is the fact that the majority of the instructors who are teaching college chemistry courses in the department have a limited repertoire of pedagogical skills and teach large classes. The advantage of the instructional cycle approach is that it also offers many opportunities for teacher learning. These changes are intended to be slow, gradual and incremental and it is anticipated that, within a relevant and feasible General Chemistry course, they will make the teaching effective. The intended outcomes are to eventually reduce rates of failures in General Chemistry courses and facilitate student progress through the university service courses.

1.2.1 Research questions

The following research questions will address the objectives:

1. How can course material be developed to maximize students' intellectual engagement, given current Philippine conditions?
2. How effective was the implementation of the teaching/learning model in terms of:
    a. instructors adopting or adapting the three phases in the approach?
    b. improving basics of classroom management including the use of books, use of class time, student tardiness and attendance, seamless transitions between phases, maximum use of homework, and monitoring of students' performance?
    c. enhancing instructors' pedagogical repertoire?
3. How has the project enhanced inter-faculty collegiality/collaboration?
4. What are students' perceptions of the teaching/learning approach?

1.3 Significance

Imagine a large science class in college or university where the instructor and students are actively engaged in discovering the fun and excitement of doing and learning science and where the emphasis of teaching is on producing meaningful learning rather than transmitting large amounts of material. This vision is intended to become a reality in all classrooms of Chem 4 courses at the University of San Carlos as a result of the course and faculty development and subsequent research.

The reconstruction of Chem 4 courses to apply the instructional cycle teaching approach served as on-the-job training for the instructors so that they can make modifications to their current teaching skills and be challenged to learn various ways of teaching. Instructors were challenged to become more positive, manage their classroom more efficiently, ask more probing questions, induce students to be more involved and productive, increase the clarity, vividness and logical presentations of their lessons, and understand better the subject matter they teach. Instructors also were challenged to assess students' performance formatively rather than the traditional rote-memorization summative test. The instructors who met these challenges would benefit by having a well-organized class and students would be more responsible and active in their learning.

Unique features of this research study included the use of a coaching approach to train and support the instructors while they were undergoing a process of pedagogical change. The coaching process facilitated the exchange of teaching methods and materials, provided instructors with regular feedback on their classroom performance, and gave one-to-one assistance during the critical implementation phase when an instructor tried out a new skill. Through the sharing of common problems and frustrations in the implementation of the new course, instructors felt less alone and acquired support from colleagues to face daily challenges with enthusiasm. Instructor anxiety was reduced and a collegial atmosphere in the department began. Collegiality is an important element to encourage all instructors to continue trying new skills in order to improve their instruction.

Likewise, the coaching process helped the researcher, who was then a less experienced coach, in acquiring a thorough knowledge of coaching strategies and skills in making a variety of observations and communicating in supportive and non-judgemental ways. She gained insights into the various problems that instructors faced in their daily teaching and had an educative transforming experience working on these problems with the instructors rather than just by herself.

The research served as an impetus for the administrators to fund the renovation of the physical structure of the classrooms. The classrooms are now air-conditioned and chairs can be moved to facilitate seatwork activities and group work whereas before chairs were nailed to the floor and arranged in a tiered way. A physically sound learning environment encouraged even a large chemistry class to be more involved and participative.

The learning experiences of these instructors engaged in using the instructional cycle approach can be shared during the in-service training courses conducted by the university, which houses the Centre for Science and Mathematics Education in a four-province region. This in-service training in turn has created a small group of chemistry teacher trainers in the university's newly built Science and Mathematics Education Institute.

Results and findings of this research will provide bases and direction for other departments in the university, particularly biology, physics, mathematics and science teaching to examine their teaching practices and the courses offered. The new General Chemistry course emerging from this study could be implemented and evaluated continuously. Further implementation and evaluation of these strategies is the intention of the Netherlands-funded project in science and mathematics education development located at the University of San Carlos.

1.4 Scope and Limitations

The Science Teacher Education Project-Southern Philippines (STEPS), a project funded by the Netherlands Organization for International Cooperation in Higher Education (NUFFIC), has been implemented at USC in collaboration with the Vrije Universeteit (Free University) of Amsterdam since 1996. The main objective of the project is to establish a Science and Mathematics Education Institute (SMEI) at USC, which will give impetus to the enhancement of pre-service and in-service teacher education in science and mathematics. A corollary to this main objective is to assist the university in improving the quality of teaching and learning in basic science and mathematics courses. Thùs, an Academic Course and Faculty Development (ACFD) program was launched as a subproject of STEPS with a focus that is both academic and technical. The intent of this study is not to cover the entire academic and technical functions of ACFD but rather to initiate a process of course and faculty development through reconstructing part one of the General Chemistry course (Chem 4).

The study has been limited to the examination of a group of instructors at a single department within the University of San Carlos. The assessment on the effectiveness of the instructional cycle teaching approach was limited to the instructors adapting or adopting the three phases in the approach; namely, improving basic elements in teaching such as efficient use of class time and the textbook, monitoring students' tasks, improving attendance and reducing tardiness as well as managing transitions between phases, and enhancing instructors' knowledge of student learning difficulties.

This study's methodology was predominantly qualitative, although quantitative components were involved in determining the perceptions of students on the effectiveness of the instructional cycle teaching approach. Generalization of the findings should be treated with some degree of caution for two reasons. First, the student sample comprised different groups of students who were enrolled in Chem 4 during the pre-project stage, pilot implementation and the departmental implementation. In the pilot implementation, many students in this group were repeaters of the course whereas in the departmental stage, students were new to the university. Second, there was no opportunity to conduct follow-up interviews with these students after the questionnaires were administered.

1.5 Ethical Issues

As a member of the academic staff of the university, the researcher's study is duly endorsed and supported by the university's administration and the Netherlands-supported STEPS project. The instructors and the school administrators were informed about their involvement in this research project during the period that the researcher was gathering background information data. Since this project is a part of the whole STEPS project, formal written permission to collect the necessary data duly signed by the supervisor from the Science and Mathematics Education Centre (SMEC) was not necessary. However, appropriate orientation was given to the university administrators by conducting a meeting of which the plan for the course reconstruction was presented, and their approval and suggestions were sought for the implementation of the research study. The SMEC supervisor was invited to come to USC, sometime in September 2000, to see and provide an evaluation of the actual implementation of this study.

The teachers' involvements in this study were explained during the conduct of in-service training; the students were informed of their participation three days before the scheduled interview. There was no parental permit needed for student interviews because students themselves were volunteering for such interviews; likewise, both instructors and students were still given the option to or not to participate in this research if they so desired. All data collected were treated with confidentiality and transcriptions of interviews and videotaped classes used pseudonyms at all times.

1.6 Thesis Overview

Besides this introductory chapter that provided background information, the objectives, the rationale, significance and limitations for this study, this thesis comprises another seven chapters. Chapter 2 presents a literature review of past research related to teaching effectiveness and the instructional cycle, the quality of chemistry instruction in colleges and universities within local and global settings, and various ways to improve chemistry instruction. Results and findings of these studies served as reference points and the framework for looking at the results of the present study. Chapter 3 explains the research methodology used in this study. The description of the sample, the place where the study was conducted, various stages of data collection and methods used in analysing the data are included. Chapter 4 describes the status of chemistry teaching in USC before this study was conducted. The chapter includes descriptive information about the teaching and learning practices at the University's Chemistry Department and identifies the problems involving classroom practices that need to be addressed. Chapter 5 reports the results on the initial implementation of the reconstructed Chem 4 course. It presents data on the course and teacher development process undertaken by two instructors who piloted the new Chem 4 course in their classes. Chapter 6 discusses the data and results of the departmental implementation of the new Chem 4 course; cases of exemplary implementation and experiences of the 13 instructors involved in this stage of the study also are discussed in this chapter. Chapter 7 describes the results of data obtained from two questionnaires given to the students about their perceptions of the implementation of the new course.

Finally, the concluding chapter, Chapter 8, presents a summary of the thesis, describes the limitations, discusses the implications for improving teaching and learning in the university, and describes future directions of this research project.

CHAPTER 2
LITERATURE REVIEW

2.0 Overview

This chapter examines literature in relation to the research project, particularly that with applications to the effectiveness of teaching, and course and teacher development, in order to provide the theoretical framework that guided the researcher to answer the research questions. There are three main sections in this chapter. The first section deals with effective teaching that supports the three phases of the instructional cycle used in the reconstruction of the General Chemistry course. The second section describes the quality of chemistry instruction in colleges and universities, both in local and global settings. In the third section, studies related to various efforts to improve chemistry instruction are discussed and analysed within the context of the course and the teacher development programs, particularly the use of coaching as a tool for effecting teacher change of pedagogical approaches.

2.1 Effective Teaching

What is effective teaching? What can instructors do that will result in students learning more, performing better in examinations or passing the course? These are concerns not only for the heads of colleges and universities but also for the public, particularly parents who expect a competent son or daughter after finishing a degree. Students also are concerned about the quality of classroom instruction that they receive and whether or not they have learned the skills needed to compete successfully for jobs that are available, or for better paying employment. In this consumerist world, college and universities — the major providers of formal learning — are held accountable to produce better results through effective teaching.

Educational research offers various methods for increasing effectiveness in teaching and learning of science and other subjects. Walberg (1991), in his syntheses of large scale educational research studies, identified nine factors that appear to increase learning. These factors are categorized into three groups and this study adopted the factors cited in the instruction category and added two factors (see * in Table 7.1) to fit the study. The modified version of Walberg's table is shown in Table 2.1.

Although the researcher recognizes the contribution of student aptitude and psychological environments in stimulating learning efficiency, these factors are inherent in the individual student and are beyond teacher control. The teachers can only alter the factors involved in instruction.

Table 2.1

Eleven educational productivity factors (adopted from Walberg, 1991)

Student aptitude
Ability or preferably prior achievement as measured by the usual learning tests
Development as indexed by chronological age or stage of maturation
Motivation or self-concept as indicated by personality tests or the student's willingness to persevere intensively on learning tasks
Instruction
The amount of time students engage in learning
The quality of the instructional experience including method (psychological) and curricular (content) aspects
Minimum lecture-time in class* (% time for lecture)
Sound classroom management system*
Psychological environments
The "curriculum of the home"
The morale or climate of the classroom social group
The peer group outside school
Minimum television viewing at home

Several teaching methods are known to have been effective for improving learning in science both in high schools (Fraser, Walberg, Welch, & Hattie, 1987; Rosenshine, 1987) and at college or university level (Biggs, 1999; Leonard, 1997; Peterson, 1979). The most popular, which already exists as far as history can tell, is conventional teaching, also known as direct or didactic teaching. In the direct instruction model, Rosenshine and Stevens (1986) label the steps or teaching functions as: (1) review, check previous day's work and reteach if necessary, (2) present new academic content or skills, (3) provide initial but guided student practice and check for understanding, (4) provide continual feedback and correction, (5) provide students with opportunities for independent practice, and (6) conduct weekly and monthly reviews. This method of teaching, like any other method, can be done well or poorly depending on the teacher and his or her environment. Successful teachers practice the following steps (Walberg, 1991): (a) daily review, homework check, and if necessary, reteaching; (b) rapid presentation of new content and skills in small steps; (c) guided student practice with close teacher monitoring; (d) corrective feedback and instructional reinforcement; (e) independent practice in seatwork and homework; and (f) weekly and monthly review. Clearly these steps reflect Rosenshine and Stevens' model.

From the above it is possible to draw out these essential functions of effective teaching: teacher modelling, students' engagement and independent performance. Similarly, Anderson, Evertson, and Brophy (1979) and Pearson (1985) outlined three phases to teach reading comprehension: (a) modelling, where the teacher exhibits the desired behaviours; (b) guided practice, where students perform with help from the teacher; and (c) application, where the student performs independently of the teacher. Cummings (2000) presented a quarter system employed by teachers to obtain effective teaching that consisted of four social or task configurations in a classroom: (a) teacher talk or presentation; (b) small-group work; (c) whole-group discussion; and (d) independent work. Although these teaching steps or functions were mostly applied in elementary and in secondary levels in various subjects, they provided a major scope for identifying the three phases of the instructional cycle advocated in this study.

2.1.1 Teaching effectiveness and the instructional cycle model

The instructional cycle model used in this study is a teaching procedure that consists of three phases: plenary, seatwork activity, and closure or summary. The cycle is an adaptation of the direct instruction model (Rosenshine, 1983; Rosenshine & Stevens, 1986; Rosenshine, 1987) and conventional teaching steps implemented by successful teachers (Walberg, 1991). Walberg's steps or Rosenshine's teaching functions one and two were combined in the plenary phase of the instructional cycle, which included a short presentation of new information or a mini-lecture after the teacher briefly reviews or checks on the previous lesson's activities. Steps or teaching functions three and four constituted the second phase in the model: guided practice with seatwork, consisting of problems, questions or activities, or discussion questions for small groups, with the instructor moving around the classroom. While going around the room, the teacher learns about student problems with the new concepts and provides students with feedback on their understanding. The teacher has an opportunity to assess the effectiveness of the mini-lecture. Phase three in the model is again a plenary phase where the seatwork is discussed and this phase is closed with a summary. A typical lesson consists of one or two of these learning/teaching cycles. However, there are lessons in which the subject matter could be divided in more than two short cycles in one and a half hours. The seatwork and the closure phases are modifications of the steps three, four and six of Rosenshine's and Walberg's model. Rosenshine's or Walberg's independent practice (step or teaching function five) is done through homework assignments that do need to be monitored.

The instructional cycle cited above is similar to the instructional cycles originally developed by Karplus and Thier (1967) and used in several studies (Abraham & Renner, 1986; Marek, Haack, & McWhirter, 1994; Marek & Methven, 1991; Renner & Marek, 1988) because all have three phases and are teaching procedures which could be applied in designing curriculum materials and instructional strategies for science. Differences lie in the aspects of each phase in the research instructional cycle model. The Karplus instructional cycle includes (1) an exploration or data gathering phase, (2) a conceptual invention phase, and (3) an expansion of the exploration phase. This cycle is a laboratory-based teaching procedure derived from the developmental theory of Jean Piaget (Renner & Marek, 1990) and requires a suitably trained teacher and a well-organized classroom. The teacher guides the students through laboratory investigations and then leads class discussion. The suitability of the Karplus instructional cycle for the Philippine context is for science courses where lecture and laboratory components are integrated and for teachers who have attained mastery of subject matter, subject pedagogy and have good classroom management skills. The Karplus instructional cycle was considered not yet applicable in the USC teaching/learning situation.

Conversely, the instructional cycle advocated in this study is applicable to any college science courses, as in the case of the chemistry courses at the University of San Carlos and for that matter most of the Philippine's colleges and universities, because these courses have independent lecture and laboratory sessions. The instructional cycle advocated in this study retains some features of conventional teaching such as the mini-lecture in the plenary and in the closure phases. Although the lecture has earned a lot of criticism and has been rejected by proponents of interactive learning, when done well the lecture is valuable in setting up a scaffold for building knowledge and presenting knowledge and skills in subsequent units

(Levine, 1982; Walberg, 1991). Appropriate chemistry language and terminology are best presented in this phase (Treagust & Chittleborough, 2001). Since chemistry topics are generally hierarchical, through lectures students can benefit from the instructor's superior level of knowledge and experience (Walberg, 1991). However, because a poor lecturer may not do any better at working with interactive methods, it is also important to retain well-implemented traditional teaching if it is an option to improve learning and effect gradual change in teaching (Fullan, 1991; Walberg, 1991).

The seatwork activity phase has features such as engaging students on task and continuous feedback to learners on their performance. The seatwork can be routine such as answering textbook questions and problems; it can also be more sophisticated using conceptual development strategies depending on the skills and experience of the teacher. In this phase, students are given the opportunity to master such skills with the guidance of the teacher and then engage in peer discussion for better learning. Peer tutoring is a form of cooperative learning and is considered to be a relief from more exclusive teacher-to-student interaction of whole group teaching (Mazur, 1997; Stahl, 1996; Wenzel, 1998). Homework assignments are given to foster independence and responsibility for learning. In this phase, students are given the opportunity to explore or expand their ideas about the subject matter. On the other hand, instructors are learning the skill of interacting with the subject matter to individuals or small groups, also learning and exploring the skill on assessing formatively while the task is on-going. In essence, the Karplus instructional cycle of exploration and expansion are applied in this phase.

The instructional cycle approach is applicable to teaching chemistry facts and decoding procedures that are hierarchical in nature (Francisco, Nicoll, & Trautman, 1998; Holme, 1992, 1993; Hooper & Webster, 1998; Kovac, 1999). In fact, Paulson (1999) had an interesting teaching technique in making some breaks and pauses during a traditional lecture chemistry course. After 15-20 minutes of lecture, he circulated among the students and was able to see the quality of their notes and answers to questions given. In some instances, students shared notes with a classmate and asked each other questions about the concepts. Student understanding of the lesson was then checked by requiring students to write down the most important idea covered in that day's lecture and this was followed by a whole class discussion. The method employed by Paulson, which he called active teaching, is similar to the plenary-seatwork-closure phases advocated in this study.

The most solid progress of learning can be attained when facts and skills are taught in a step-by-step manner and learners are allowed to master them before going on to another concept or skill. Poor progress of students could be resolved by giving more work, in this case through homework assignments, until mastery learning is attained. Teacher support can be withdrawn once students achieve independence (Vygotsky, 1978).

2.1.2 Teaching effectiveness and learning time

An educational productivity factor identified by Walberg (1991) that appears to increase learning is the amount of time students engage in learning. Researchers in the mid 1980's focused on instructional time as a component of education compensation and evaluation for beginning teachers. Troisi (1983) identified three types of instructional time: allocated time, engaged time and academic time. On the other hand, Evertson (1982) used seven categories to determine the organization of student task engagement as a measure of student attention in mathematics class. The categories were: (1) definitely on-task academic, (2) probably on-task academic, (3) definitely on-task procedural, (4) probably on task procedural, (5) off-task sanctioned, (6) off-task unsanctioned, and (7) dead time.

Although Troisi presented a clear definition of each type of instructional time, the researcher modified the definition in order to be specific in describing the learning time as used in this study.

- Allocated time is the time scheduled for a subject or a course.
- Academic learning time is the total actual time teacher and students spend in appropriate learning activities in class.
- Engaged time or time-on-task is the amount of time students actually spend in learning activities set by the instructor. The learning activities could either be done individually or in small groups.

Research has shown that increasing the amount of time for science can enlarge and enhance learning time (Frederick & Walberg, 1980). This does not mean taking away sessions in other subjects to spend double or triple sessions in science classes but providing optimal guidance, corrections and encouragement to ensure success of engaged time. Unfortunately, many college instructors spend too much time on whole class lecturing and less time engaging students on task. Davidson (1979), after following 227 students in Austin, Texas for an entire day, found that 20 percent of each school day was devoted to non-instructional activities such as waiting for teacher instruction, announcements and moving from one class to another. Only 3.75 hours were spent on actual learning time. Analysis of the teaching methods used by 60 primary school teachers in the United Kingdom revealed that approximately one-third of total teaching time was spent on whole-class or traditional teaching (Wragg, 1993).

Time-on-task is related to achievement and the greater amount of allocated time and academic learning time, the more students learn which results in higher achievement (Troisi, 1983). Likewise high levels of engaged time and achievement are directly associated with mastery learning (Bloom, 1976) and direct instruction teaching (Evertson, 1982; Rosenshine, 1979, 1983). In addition, successful teachers demand time for students, do not waste the time they are given, devise ways to motivate students to volunteer as much as possible, and create activities that make learning efficient (Zielinski, Brooks, Crippen, & March, 2001). Aside from allocating more time for learning science, a well-organized and well-managed classroom could result in more effective teaching.

2.1.3 Teaching effectiveness and classroom management

Good teaching is not a genetic trait – it is a learned skill (Druger, 1997). An effective teacher finds ways to help students learn. Meaningful interaction between the teacher and students and among students must be established and this can happen under a learning climate where students know what is expected, what they are supposed to do and what materials to use. Students listen to and respond to teacher presentations. Transitions from one activity to another are accomplished quickly and with a minimum of teacher direction. Activities move at a brisk pace and when work is required, students go about the task seriously and independently (Brophy, 1988;

Reynolds, 1992); they know how to transfer skills and what behaviour is permissible in the classroom.

An effective teacher knows what is happening in all parts of the classroom, prevents problems from happening through well-prepared lessons and is able to maintain an orderly atmosphere. Good classroom management is important because it enables the teacher and students to engage in more productive learning activities with optimum use of the allocated time. Likewise, an effective college science teacher must possess desirable personal attributes and an arsenal of good management skills (Druger, 1997; Evertson, 1987).

Good planning and preparation lead to establishing conditions conducive to effective learning. The teacher must have background knowledge of his/her students' skills, prior learning and learning style, in order to create an environment that recognizes the needs of individual students and cultivates positive motivation, trust and deep learning. Troisi (1983), in his analysis of research on teaching effectiveness and classroom management, listed desirable behaviours of an effective classroom manager. The same behaviours were exhibited by the successful instructors found in this study. These behaviours are:

- Made clear the rules, consequences and procedures on the first day and adhered to these rules consistently throughout the year. Deadlines were clearly indicated and enforced. He or she also provided a role model for students by a businesslike approach to teaching;
- Kept students on academic tasks and promoted extensive content coverage. Stressed high-quality work and students were urged to work to the best of their ability.
- Maintained a work-oriented focus and emphasized care and accuracy in completing assignments. Provided specific motivational material for students who completed assignments.
- Followed-up on assignments in class, graded homework assignments, and kept careful records of student work.

- Insisted on the students' attention to instruction. Monitored the class constantly to ensure students working steadily and accurately.
- Created a supportive learning atmosphere by showing concern and respect for each student. Provided remediation to individual learning deficiencies with specific transferable skills;

Research has also shown that a well-managed classroom has been consistently associated with students' achievement and attitudes (Evertson, Anderson, Anderson, & Brophy, 1980; Medley, 1977). For example, high achieving junior high school students described an effective mathematics teacher as one who took personal responsibility for management and discipline in his or her classes and communicated to students the rules of class operation and expectations in his or her class, while an effective English teacher demanded that students pay attention to instruction and make up for missed work (Evertson et al., 1980). Even the low achieving students described an effective teacher as self-confident and self-reliant in dealing with behavioural problems, showing trust, care and professionalism. More so, a well-organized classroom had a high proportion of time spent on task-oriented instructional activities.

Direct instructional methods were reported to increase student learning when used with the whole class or small group to teach basic skill mastery (Good & Grouws, 1979; Rosenshine, 1987). Learning gains were related to task orientation or stage setting; well planned and logical presentation; more probing questions to improve student response, enthusiasm and frequent teacher communication.

As stated earlier, for effective learning in the classroom, teachers need to be business-like and task-oriented, use appropriate classroom management and organization strategies and pace students briskly through the curriculum (Brophy, 1988; Reynolds, 1992). Teachers who can create and maintain that learning occurs smoothly are obviously at an advantage. Other techniques were suggested and used successfully to set the tone for effective classroom teaching. One strategy that this researcher found useful was establishing routines in class. A routine as defined in the dictionary (Macquarie, 1998) is a regular course of action or conduct, a way of doing something in the classroom as established by both the teacher and the students (Gump, 1969), and has its own set of rules and language (Edwards & Mercer, 1987).

Each semester teachers are faced with a new group of students. Therefore, a major task for the teacher and the class during the beginning of each semester is the establishment of classroom routines whose smooth functioning is necessary for the efficient delivery of instruction. Effective classroom managers teach such routines to their students in the early weeks of classes. The teaching of routines is likely to be particularly problematic in innovative programs because many of the routines are relatively new to teachers as well as to students (Emmer, Evertson, & Worsham, 2000). Appleton (1995) suggested three key steps that a teacher should take to establish routines. First, identify and list all the routines that are useful in the classroom. Second, indicate the rule that should be applied for each routine and thirdly teach each routine to the class. Three out of five routines implemented by Appleton are applicable in this study. These routines and the possible associated rules are shown in Table 2.2.

Table 2.2

Some routines and possible associated rules

(Adapted from Appleton, 1995 p. 294)

Routine	Rules
Teacher explaining at chalkboard	- Students sit at their desks. - All attend to the teacher; no other activity is permitted. - No talking among students is permitted. - Students respond to teacher's question by raising their hands. - The teacher selects who will speak. No student may get up from his or her seat without permission.
Individual seat work	- Students sit at their desk. - Students work on the set task from the chalkboard, book, or worksheet. - No talking among students is permitted. - Students requiring assistance raise their hands. - Students are not permitted to leave their seats without permission.
Small group discussions	- Students work in the small group they are assigned to and sit as a group facing each other in a circle. - Students may not change groups or visit other groups. - The group works on the set task. - Talking among students that is on task is encouraged. - Off-task talking is discouraged. - Overall noise levels must remain at an acceptable level. - Groups requiring assistance must raise their hands and wait. - Students should take turns and be polite when discussing.

In her effort to curb disruptions during her class, Charney (1998) developed seven strategies and established them as routines to create a smooth-running class. These strategies are presented in Table 2.3 so that accompanying action for each strategy can be highlighted.

Table 2.3

Seven strategies and accompanying actions for smooth running classes

Strategy	Action
1. Set expectations.	- Give students a sense of your vision for the tone of the classroom.
2. Name and define the behaviours you want students to learn and make sure to reinforce them.	- Generate simple rules of respect during discussion: raising hands, not interrupting, not making put-downs.
3. Model appropriate and alternative behaviour.	- Develop an arsenal of strategies.
4. Set-up routines such as wait times.	- Use signals such as raising hands or thumbs up
5. Settle on predictable consequences for blurting out.	- Give simple but emphatic reminders or redirection.
6. When communication breaks down, let the students start again.	- Give reminders and interventions.
7. Pose a class challenge to be disruption-free.	- Set an agreement with students for a 30-minute lesson without disruption.

The researcher purposely includes these examples because many of the routines and rules cited reinforced the routine practices suggested during the coaching of instructors while implementing the new Chem 4 course. Furthermore, the researcher believed that once suitable routines and conditions are established and maintained, any teacher, regardless of the academic level, can deal with content efficiently and effectively so the students' work is focused and on-task behaviour is high. Further, discipline problems are reduced, and students feel greater satisfaction in the purposeful learning environment generated (Appleton, 1995).

2.1.4 Measuring effectiveness in teaching

Many classroom researchers have examined different variables to distinguish effective and ineffective teaching. For example Lederman (2001) identified patterns of teacher behaviour and classroom climate to assess teaching effectiveness; teacher behaviours included clarity, variability, enthusiasm, criticism and indirectness while classroom climate was described as being task-oriented or business-like, providing students with an opportunity to learn criterion materials and use of structuring comments. Likewise, specific aspects of an instructor's teaching style also were included as criteria for assessing the effectiveness of teaching (Hobson & Talbot, 2001). These aspects included "organization, planning or structure; teacher-student interaction or rapport; clarity in communication skills; course workload and difficulty; grading, examinations and assignments; and student learning, student self-ratings of accomplishments or progress" (Centra, 1973, p. 290).

Other instructional dimensions of effective teaching advocated by Marsh (1981) and Feldman (1988) were learning or value; instructor enthusiasm; organization; group interaction; individual rapport; breadth of coverage; examination/grading; assignments; and workload/difficulty. Likewise, a pre-test and post-test when given on a regular basis within the course can be used to determine valuable information that can measure student learning and can suggest areas for teaching improvement and enhanced course delivery and learning outcomes (Simkins & Allen, 2000). Carey, Perrault and Gregory (2001) have a broader perspective in measuring teaching effectiveness; this assessment approach measures student-learning outcomes course-by-course within the program and at graduation and during students' professional lives. This practice could shift the view of the college/university's teaching mission from a narrow focus on each instructor in assigned classes, to the broader perspective of how well the college/university is preparing students for careers and how different instructors are contributing to that preparation.

Troisi (1983), on the other hand, clearly categorized four teacher effectiveness variables, namely, personal, context, process, and product. The personal category includes the training or teaching experience, out-of-school experiences, beliefs and personality of the teacher. The context category describes the classroom environment, classroom space, and geographical location as well as the number of students, student ability, and quality of home nurturing. The learning activities in which teachers and students participate are included in the process category as a result of teaching. The learning of students as measured by tests and students' feeling about the knowledge areas is the domain of the product category.

As the categorization shows, measuring teaching effectiveness is complex due to the uniqueness of people in the classroom. Teachers are faced with many simultaneous challenges: managing space, time, equipment; resolving student behavioural problems; presenting subject matter; and making judgments and decisions while considering different ability levels of students. On the other hand, students deal with teacher's unique motives, purpose, personality and experiences (Troisi, 1983).

Effective teaching is not only a matter of applying the principles of teaching but adapting these rules to the teacher's own personal strengths and teaching context. It involves setting up teaching and learning aspects so that students are fully engaged in the various actions needed to achieve the desired outcome (Biggs, 1999). Several aspects include motivation that could initiate learning and maintain engagement during learning. Setting the classroom climate that builds on mutual trust among the stakeholders in the classroom would likely strike the right balance for optimal learning. Drawing out the specific teaching/learning tasks that best serve the needs of the students is an aspect that needs focus. Teaching methods must shift from that of giving out information to one where students are taught how to access, evaluate and utilize information (Byers, 2001; Hanson & Wolfskill, 1998; Spencer, 1999).

In science education, varied teaching styles are adopted to engage students in the learning process. Integration of multiple teaching strategies in the classroom improves not only student participation but also the chances for the teacher to channel the cognitive strengths of a diverse student population (Francisco et al., 1998). Placing emphasis on learning rather than teaching gives real opportunities for students to understand major ideas of the topic and enables the teacher to picture the progression of these ideas (Burke & Walton, 2002; Caprio, 1997).

2.2 Quality of Chemistry Instruction in Colleges and Universities

It is widely recognized that undergraduate general chemistry classrooms use lectures as the dominant mode of teaching. The instructor talks and writes at the front of the class while the students listen or busily take notes at their desks. Although the lecture mode of teaching can cover large amounts of material, student's learning or understanding of the subject matter cannot be assured (Francisco et al., 1998). The traditional lecture format as often practiced limits the active involvement of students in learning the subject matter during class and misses opportunities for students to engage in chemistry. Research shows that this traditional teaching method is no longer meeting students' educational needs (Hanson & Wolfskill, 1998). Unfortunately, one outcome of this situation is that the introductory chemistry courses in high school and first-year university have a reputation among students for being uninspiring and irrelevant to their interests (Gillespie, Spencer, & Moog, 1996; Singh, 1999). Such a reputation is certainly undesirable. Part of the blame lies with the content of the course and those who teach it.

2.2.1 The quality of chemistry course content

Chemistry is certainly a complicated subject; many students and teachers believe simply that chemistry is difficult. Students have attributed their difficulties to the cumulativeness of the subject matter, to too many rules and exceptions to the rules, to being too abstract and being mathematical such that the course requires a special way of thinking (Carter & Brickhouse, 1989; Singh, 1999; Wruck & Reinstein, 1989). Likewise, chemistry courses are characterized by macroscopic, molecular and symbolic systems of knowledge that seem to have no relationship to the real world of the students (Bodner, 1992; Gupta & Parkash, 1999). These findings mean that the structure of the course seems to support the belief that if the instructor does not discuss a topic in class, the students cannot be expected to learn it. However, evidence suggests that covering less material, but doing it well, may produce better learning students (Bodner, 1992; Olmsted, 1999). Indeed the sequence of topics that make sense to the instructor is not necessarily the sequence of topics that will produce optimum learning. Undergraduate chemistry courses seldom incorporate practical applications where students can relate chemical laws and theories to daily experiences. Techniques that encourage students to work in teams are rarely promoted. Often chemistry students are expected to work individually and working together is considered suspect (Towns, 1998).

2.2.2 The quality of chemistry instructors in college

Most college-level instructors of chemistry proceed directly from a graduate program to the classroom without any pedagogical training. This situation results in instructors teaching the same way they were taught where the emphasis is on providing instruction rather than producing learning (Spencer, 1999). Moreover, these instructors have very little knowledge of cognitive theories of the learning process. In a similar manner, beginning and experienced instructors usually have goals that are too high and test items are mismatched. "Too often, chemistry instructors structure examination questions that can be answered by memorization or the application of an algorithm" (Sanger & Greenbowe, 1996, p. 533).

The survey conducted by Carter and Brickhouse (1989) indicated that teachers and students agreed that there were not enough examples, applications and problem solving in their chemistry classes. Furthermore there was a lack of consistency between the examinations, homework and lectures. Low scores in examinations are interpreted by the instructor as students not understanding the material. However, Spencer (1999) recognized that the ability to answer a test question does not necessarily imply mastery of a subject. Likewise, Mazur (cited in Spencer, 1999 p. 566) pointed out that "it is possible for students to do well on conventional problems by memorizing algorithms without understanding. It is also possible for a teacher, even an experienced one, to be completely misled into thinking that students have been taught effectively".

Students complained that instructors make chemistry seem more abstract, more mysterious and more esoteric than is necessary (Wright, 1996). Poor instructors are unable to model for students the basic science skills to be developed during a chemistry class. They also fail to provide an overview of how the topics in a chemistry course fit together, while focusing on a certain science skill at one point in the course (Hanson & Wolfskill, 1998; 2000).

On the other hand, instructors often accuse students of having a passive learning style such that they are less participative and do not assume responsibility for their learning (Wright, 1996). This result is supported by the unanimous concerns of instructors from 42 institutions in the United States, including community colleges, liberal arts colleges and large research universities, that students have difficulty understanding and applying concepts, finding relevance, transferring knowledge within and across disciplines, and identifying and developing skills needed for success in college and a career (Towns, 1998). Indifference of students in chemistry resulted in low scores on tests that are interpreted as not understanding the subject matter.

2.2.3 Quality of science instruction in the Philippines

Local studies illustrated that the teaching of science in the Philippines is still based primarily on the chalk and talk expository and lecture methods (Ibe & Ogena, 1998). For example, a case study on biology classroom practices found that the teaching emphasized the learning of definitions and facts to be memorized and reproduced during tests (Brioso, 1997). Lecture is the dominant mode during a class session when students take down notes; interaction with students is generally done through question and answer, with questions that are mostly recall and of low-level. Low-level questions require one-word answers and call for memorization of facts, definitions, statement of laws and formula. The rhetorical questions asked by teachers require a choral answer without thinking (Berg et al., 1998). Teachers are misled in their own thinking that the choral answer practice is an indication that students are closely following the lesson, while in reality they only give a word or statement from the book or notes without understanding (Berg & Saniel, 1996).

In most instances, the whole class session is spent for review of the past lesson and introducing a new topic. Students are rarely involved in activities that would encourage them to practice and apply their knowledge and skills within the session, and the teacher does not have a chance to monitor student work. This practice does not reinforce conceptual learning nor stimulate students thinking. Though high level types of questions are rarely asked in the majority of science classes, they do exist in some classes (Somerset et al., 1999). High-level questions encourage students to think of what they know, analyse or synthesize the information so that they can apply it in other situations. Probing questions are just one type of high-level questions that can stimulate students to think and construct their own knowledge. As an example, a lesson in a Philippine grade-8 Biology class used a mixture of low and high level types of questions. Low-level questions were of the type that asked for enumerating facts and stating definitions. An example of this type of question is, what is mutual relationship? High-level questions were of the type that stimulated students to think and probe their understanding of the terms mentioned. For example, the question, who knows about parasitic relationships? was followed up by another question, why are they parasites? In answering these questions, students would first tend to state the definition of parasitism. However, the teacher could lead the students to apply their knowledge in a different context, by asking them to give other situations illustrating parasitism. And if they did, this is an indication that students can construct their own knowledge, given the proper environment.

2.2.3.1 Classroom methodologies

There are a number of teaching methods that the science teacher can adopt as he/she is in control of the class and the learning of students throughout the session (Berg et al., 1998). However in most cases, the sessions are dominated by a lecture and dictation with extremely rare alternative methods such as demonstration, Predict-Observe-Explain (POE) activities or concept mapping that could enhance active involvement of students. Most of the sessions in Philippine classrooms follow a pattern of teaching methods — review, dictation and note taking, class discussion and evaluation — and this goes on daily.

Review is always the initial activity of the teacher, either done by stating a brief description of the previous lesson or asking recall questions that emphasize memorization of facts and definitions. Sometimes, a review of the past activity and feedback on the results of the previous experiment is done (Berg & Saniel, 1996; Somerset et al., 1999)

Dictation and note taking occur frequently in schools where textbooks are scarce so the teacher dictates a paragraph or more from a book while the students take down notes. Other teachers let a student copy a portion of the topic from the book onto the board and the rest of the students copy into their notebooks. This practice takes about 60-70 % of class time and sometimes the whole period is utilized, depending on the topic (Berg & Saniel, 1996). In this way, the teacher has control of the quality of books and references that he or she uses. In actual practice, however, the resources used do not match the level of understanding and preparation of the students. For example, one study indicated that books and handouts acquired by the teacher during in-service training were the ones used with their high school classes, regardless of whether that class is composed of high or low achieving students (Berg et al., 1998).

Class discussion is one of the most popular teaching techniques that teachers use. Some teachers use this after dictation and note taking (Berg & Saniel, 1996), others after giving a reading assignment, while some when introducing a new lesson or topic. Class discussion in many ways is a good technique where responses of students can be solicited, but the learning atmosphere should be well established to stimulate active participation and real learning among the students. In many cases, class discussion is disrupted by problems related to classroom management and teachers then have difficulty in regaining the attention of the students and so interaction can be possible without learning the concept (Berg & Saniel, 1996).

Evaluation consisting of quizzes and tests are the common forms of assessment, although some teachers use oral recitation and constructed-response questions (Berg et al., 1998; Somerset et al., 1999) as tools to evaluate a student's learning. Classroom tests used in assessment measured the memorization of facts, definitions, laws and formulae. Most of the test questions required one-word answers. Since this type of test does not reinforce meaningful learning, what most students consider important is that which is evaluated and tested (Brioso, 1997). In many classes, students do the marking of the tests after exchanging papers, calculate the total score and later the teacher records the scores (Berg et al., 1998; Somerset, 1998). Teachers usually only copy the scores into their grade books and do not seriously look at any of the peer-marked papers. They themselves admit this during in-service trainings. That way there is no quality control on the peer correction process and teachers do not learn about typical student difficulties. Just a thorough inspection of five of the 60 papers could produce useful feedback on the teaching-learning process and pointers for the next lesson. This peer marking of tests deprives the teacher and students of feedback on the teaching and learning situation.

Homework is normally given at the end of the session, either orally or written on the board. The most popular homework is reading some pages from the textbook, studying notes or solving algorithmic problems. To ensure that students work on the homework, the teacher either announces a quiz about the readings or students are asked to submit their answers on a paper. The irony is, once homework is submitted, students don't receive any feedback nor does the teacher use this homework to start or link the next lesson (Berg & Saniel, 1996).

2.2.3.2 Performance of students in science

The low achievement of Philippine students in three international studies — the Second International Science Study (SISS) which was held in 1975, the Third International Mathematics and Science Study (TIMSS) in 1995 and the TIMMS-Repeat in 1998 — provides an overview of the quality of science instruction in the country. The Philippines ranked 40th in science among 41 countries in TIMSS. The TIMSS items test students' ability to comprehend, apply and analyse the given data in a problem. Few of the TIMSS items call for simple recall of principles; some call for straightforward computations; most are on simple problem situations, which, however, the Filipino student sample could not answer correctly. "The items on measurement, for example, are simple and easy; they call for comprehension, but they do not fall into the item mould which students are used to answering in tests in the classroom and in workbooks or textbooks" (Ibe & Ogena, 1998, p. 18).

The performance scores of students at the elementary, secondary and tertiary levels continue to indicate that science is one of the difficult subjects. In the 1996 National Elementary Achievement Test (NEAT), the mean performance scores of the 6th graders in the test is within the range of 30 to 40%; that is, only 15 out of 40 items in the test are answered correctly (Ibe & Ogena, 1998); thus the low mean scores in the TIMSS is not a surprising one.

At the high school level, the same outcome is evident. In the National Secondary Achievement Test (NSAT) conducted in 1996 and in 1997, the mean percent score of students is below 50% (Ibe & Ogena, 1998). NSAT is a 250-item test conducted simultaneously throughout the country every school year. Even the students in the science-augmented classes showed low means in science (38.2% for special science classes and 33.2% for regular classes for the test conducted by the Science Education Institute-Department of Science and Technology (SEI-DOST) in 1997. The diagnostic test in chemistry administered by Somerset (1998) complemented the NSAT results. Analysis of the chemistry test results revealed that most fourth year students retained little of the chemistry to which they were exposed during their third year. This result could also be an indication that the teaching emphasis is on memorization and rote recall. The analyses further showed that students from the science-augmented schools performed better than the students from the regular high schools. However, students from both schools displayed a limited knowledge of basic and key principles in chemistry. The slightly better performance of students in science-augmented schools is supported and complemented by its enriched science curricula, but the methods of instruction are unlikely to be the factor considered.

Entrance tests to universities show many students to have below the 50% mean scores in mathematics and science, just as consistently occurred in NSAT (Ibe & Ogena, 1998). A major concern is to identify those factors that could have contributed to the low performance of Filipino students in science. Many parameters are pointed out as causes for the current state of science education in the country (Ibe & Ogena, 1998). Some of these parameters are teacher training, instructional materials, teaching and learning process, school curriculum, absence of science culture and, of course, governance.

2.3 Efforts To Improve Chemistry Instruction

Teachers and students have inherited accumulated wisdom about teaching and learning. The great teachers of the past, like Socrates and Comenius, contributed to the foundation of the educational tradition that has survived and grown because in general it worked well. However today, we have to improve the effectiveness of the many teachers, who are doing less well than they are potentially capable of doing, and of learners who are not learning as effectively as they might, with proper training or motivation. The general notion and important direction of reforming education, particularly the improvement of teaching and learning, should depend to some extent on the status of the course and teacher background. This implies that reform efforts must start with the courses and teachers and build on this information accordingly.

In science education, recent reform efforts placed emphasis on the improvement of student science achievement (Bybee, 1993; Robinson, 1996; Walberg, 1991). In these reforms, development programs are continuously structured to intensify and sustain curriculum changes, instructors' training and improvement of support facilities for teaching. Many colleges and universities are actively engaged in trying new approaches, instructional strategies and new arrangement of content. Among the aspects considered in improving instruction are the following: (1) the organization of new course paradigms and the benefits that the new course can offer to students, teachers and the institution, (2) the best approach to help teachers adapt to the new style of delivery, and (3) the best practices that could be drawn upon that could serve as models for other disciplines and institutions.

The growth approach advocated by Main (1985) recognizes the enhancement of teachers' potential as a continuous learner. This approach as describe by Orlich (1989) emphasises not only teachers' active involvement in educational decision-making processes and in solving instructional problems but also a humanistic rather than a mechanistic perspective of teachers. Such framework is translated as the professional, personal and social aspects of a teacher development process that is viewed as interdependent from each other (Bell & Gilbert, 1996). These aspects of teacher development are considered when teachers consider shifting the center of attention of classroom activities from the teacher to the student and exploring their new roles during a transformation of their own classrooms. Loucks-Horsley, Hewson, Love & Stiles (1998) assert that the key to the implementation process either in course development or professional development includes phases such as of setting goals, planning, doing and reflecting. Building on the existing theories of course and teacher development, these aspects are explored for relevance to this research.

Lijnse (1995) defines and describes developmental research. In such research course developers go through many iterations or cycles of course design, try-out, evaluation and revision. Usually there are no control groups but the course is continuously assessed against its own objectives, but even these might change in successive iterations. Some 15-20 doctoral theses have been produced at the University of Utrecht using this model, most recently Smits (2003). The research in this thesis fits this realistic developmental model. "Developmental research means experiencing the cyclic process of development and research so consciously, and reporting on it so candidly that it justifies itself, and that this experience can be transmitted to others to become like their own experience" Smits, 2003 p. 63).

In the Philippines, science education is not only confronted with the shortage of science teachers, particularly Chemistry and Physics teachers, but also with the subject incompetence of these teachers. Even at tertiary level subject competence of science teachers is a real problem. For example, the associate supervisor's experience in teaching a masters degree course on misconceptions in Physics conducted in USC confirmed that college lecturers from other universities showed extremely weak Physics backgrounds. Conference workshops with university instructors confirm this as well. Many lecturers have such a weak conceptual background that they cannot do much more than teach for memory. The same result was revealed in the analysis on the results of the Professional Board Examination for Teachers (PBET) and the Licensure Examination for Teachers (LET) (Ibe, 1995; 1997). Findings indicated that the overall performance scores in science of the LET examinees were very low, implying that the graduates of the many institutions do not acquire sufficient knowledge from the science or mathematics major course they finish; likewise this result had a bearing on the poor quality of training programs the in-service teachers went through.

In chemistry, a study on the chemistry instruction in some private tertiary institutions in northern Philippines showed that college teachers were not fully qualified to teach chemistry and that their students did not possess the needed competency in chemistry (Bambico, 1997). The lack of sufficient depth in the subject content hindered the teachers to innovate, improvise and teach the concepts and skills mandated in the chemistry course. At the USC Department of Chemistry, the situation is better when educational qualification is used as a gauge for competency. All instructors have first degrees in Chemistry or Chemical Engineering and are licensed chemists; at other universities non-majors, such as engineers, often teach Chemistry and Physics. Yet even at USC Chemistry, there are problems with instructors' understanding of basic concepts.

The reported downward trends in both teachers' and students' performance in science at any level became a major concern of any reform efforts in the country. Science education reform programmes have been directed at improving the content knowledge of teachers, upgrading laboratory facilities and resources, revising curricula, and developing better achievement tests. Examples of past and recent foreign assisted projects implemented in the country to improve science instructions are described in the following paragraphs.

The Philippine-Australia Science and Mathematics Education Project (PASMEP) was a joint project implemented by the Philippines and Australian governments with the main objective of upgrading the quality of science and mathematics education in secondary schools and teacher training in the Philippines (Yoong, 1992). The project coincided with the launching of the Secondary Education Development Project (SEDP) in 1988 to reform the secondary school curriculum that included a new curriculum for eight subjects, including science and mathematics, and writing and publishing new textbooks. For the period 1989-1993 more than 3,500 teachers underwent a training program and these teachers served as trainers to 170,000 in-service teachers from both public and private high schools under the SEDP (Somerset, 1998). The science and mathematics components were handled by PASMEP which also provided about A$8 million worth of science and mathematics equipment to selected secondary schools. In-service training courses ran from 15 to 30 days. USC, being one of the identified Teacher Training Institutions (TTI) in the region, particularly its Chemistry and Physics Departments, assisted in the implementation of the training courses in science.

The Science Teaching Improvement Project (STIP) was a project with support from the German government through the German Technical Cooperation Agency (GTZ). This project was instrumental in the creation of the National Science Teaching and Instrumentation Centre (NSTIC) that is based in Cebu City — the setting of this study. The Centre's task is to develop prototype science equipment, which then becomes a model for mass production in factories. The mass produced items are provided to public schools. The project also developed lessons based on improvised materials and conducted training for over 1000 teachers. The researcher was trained in the use of improvised equipment for the development of chemistry concepts. She also served as a trainer for high school teachers and for her colleagues in USC in the use of starter experiments. The starter experiment approach (SEA) was patterned from the Karplus instructional cycle cited earlier (Schonherr & Berg, 1996).

The high school component of the Engineering and Science Education Project (ESEP) supported the curricular changes initiated by SEDP. With the World Bank support from 1992-1997, this project, which was implemented by the Department of Science and Technology (DOST), was directed towards strengthening the quality of high school mathematics and science facilities such as laboratories, apparatus and materials to 110 selected high schools in different regions and divisions in the country (Somerset, 1998). The science and mathematics teachers of these schools were trained at the nearest Regional Science Teaching Centre (RSTC). USC, being the RSTC for Central Visayas Region, hosted and implemented the intensive subject-content course within a range of six weeks to three-semesters period of training.

The Science and Mathematics Education Manpower Development Program (SMEMDP) was funded by the Japan International Cooperation Agency (JICA) and was based at the Institute of Science and Mathematics Education at the University of the Philippines (UP-ISMED). The project that began in 1995 advocated the practical work approach (PWA) in teaching science and mathematics. The teacher-training program stressed the use of PWA and the development of appropriate instructional materials (Marinas, 2000).

The Philippine-Australia Project in Basic Education (PROBE), initiated in 1995 until 2000, was funded by the Australian Agency for International Development (AusAID). The project focused on the teaching and learning of science and mathematics in elementary Grades five and six and in high school First year (General Science) and Second year (Biology) classes; also the focus was on English throughout the elementary and high school levels. Teacher support units, called Learning Resource Centres, for both pre-service and in-service teacher training were created with the main purpose of developing curriculum and teacher support materials that encouraged student-active approaches to teaching and learning. Likewise, 346 teachers received training from the University of Queensland, Australia to become In-service Facilitators (ISF) in order to provide direct support, encouragement and training of other teachers (Acedo, 2002; Marinas, 2000; Somerset et al., 1999).

The Continuing Studies in Education via Television is a joint project of the government's Department of Education, DOST, and a television station (before it was PTV 4 but now it is NBN 11), UP-ISMED and the Foundation to Upgrade the Standards of Education (FUSE). This on-going project aided science teachers to upgrade their competencies through Continuing Science Education via Television (CONSTEL) (Marinas, 2000). Teaching episodes in science are regularly shown on the NBN 11 television station at a specified time so that teachers can make use of them during their classes.

The Science Teacher Education Program for the Southern Philippines (STEPS), funded by the Netherlands government through the Netherlands Organization for International Cooperation in Higher Education (NUFFIC), was initiated in 1996 and scheduled to last until 2004. Its purpose was to establish a Science and Mathematics Institute (SMEI) in USC and to develop strong pre-service teacher education programs in physics-chemistry and physics-mathematics. The project provided technical and financial support in the development of more effective science and mathematics teacher education programs both in pre-service and in-service at USC. It also assisted USC in improving the quality of teaching and learning in the basic science and mathematics courses for engineering students, commerce students, and other programs. That assistance gave the researcher, who had been actively involved with STEPS, an impetus to look closely at the college chemistry classrooms in USC, which resulted in this study. This research project became a pilot study in course and faculty development and in the two years since, some 20 courses in Physics, Chemistry, and Mathematics have been redeveloped with extensive coaching of implementers.

2.3.1 Redesigning the chemistry course for improved teaching and learning

It is important that future college graduates should be chemically literate so that they can understand how chemistry is important in solving many problems that face humanity today. School stakeholders have recognized that reforms of the chemistry curriculum are deemed necessary if not described as being long overdue. The chemistry curriculum is concerned with the aspects of course content, in-class instruction, out-of class assignments, and assessment. These aspects are considered in redesigning a chemistry course to improve teaching and learning.

2.3.1.1 Course content

The new structure for college chemistry curricula proposed by Clark (1999) includes (a) basic chemistry, (b) intermediate chemistry, (c) advanced chemistry and (d) specialized chemistry. These subdivisions are based on his beliefs that courses through the third year should be nonspecialized and that students should not be exposed to theories, which are explanations of things, until they have grasped what is to be explained. In Australia, an innovation in chemical education adopted a tight but integrated approach that emphasized the importance of the learning contexts for each of the topics and required the tight integration of these learning contexts with all the curriculum elements, from rationale to assessment tasks (Beasley, 1996; 1992). Learning chemistry in context introduces definitions, concepts and symbols on a need-to-know basis; that is, students describe and explain the world around them as they encounter it and use this information rather than defining and categorizing ideas first (Gillespie, 1996; Stout, 2000). A course of this type helps students make connections between the chemistry they are studying and the world around them.

Similarly, Pinkerton (2001) used a curriculum design that aligns all the topics and tasks with the student-centred goal of maximum personal success. The curricular organization depicted five layers: (1) focus questions, (2) concept clusters, (3) formal laboratory sessions, (4) tests, and (5) menu activities. The outcomes of the curriculum alignment project were enhanced student motivation and achievement, and teachers having a better perception of curriculum design.

There is also a need to design the chemistry course appropriately to the discipline. After an extensive review of engineering and chemistry textbooks, Hawkes (2000) outlined the topics that need to be emphasized in the General Chemistry courses for engineers. Content for inclusion was judged by criteria such as, relevance for prospective engineers or chemists, how it relates to objectives of the course and goals of the college, and how it represents an understanding of the discipline. For elementary and secondary education majors, their chemistry course would provide a solid conceptual understanding of chemical principles as manifested in real world phenomena and classroom instruction that would model the conditions and resources typically available in elementary and high school classrooms (Burke & Walton, 2002; Kelter, Jacobitz, Kean, & Hoesing, 1996).

The common features of these innovative chemistry curricula include: (1) an interactive model of curriculum development that employs a dynamic equilibrium among content, instruction and assessment; (2) integrated multiple teaching methods that draw from cognitive science approaches to curriculum design; (3) putting concepts as a priority in curricular activities; and (4) improved content learning, attitudes to chemistry and developed thinking and communication skills.

2.3.1.2 In-class instruction

The undesirable reputation of introductory chemistry courses among first year university students (Gillespie et al., 1996) is attributed not only to the course content difficulty and overload but also to the way the course is taught (Kirkwood & Symington, 1996). In large-enrolment introductory chemistry courses in college, chalk and talk lecture delivery remains the primary method of instruction. Despite the criticisms of the traditional lecture format, many college instructors are reluctant to abandon the method. However, a number of instructors have developed and used various teaching pedagogies to make a lecture more meaningful and productive. Such techniques include pre-lecture assignments, active and collaborative learning methods.

2.3.1.3 Pre-lecture assignments

A pre-lecture assignment is given to enhance student preparation for lectures. Reading the appropriate material in a textbook ahead of time is the common practice. As an example of this approach to ensure that students carry out their reading assignments, Mazur (1997) introduced reading quizzes in his Introductory Physics class where each lecture period begins with three or four short questions. The problem with this technique is that many students find reading quizzes punitive while others simply read the text, memorize terms and formulas, without trying to understand concepts and ideas. This problem led to the introduction of reading summaries as an alternative approach to reading quizzes (Mazur, 2000). In reading summaries, students are required to hand in, at the beginning of each class, a two or three paragraph summary of their reading assignment. Advantages were noted using this method: (1) students read the material substantially better than the reading quizzes as seen by a well-responded concept tests during the lecture, (2) attendance was high, and (3) all students came to class on time.

A similar approach was used by Collard, Girardot and Deutsch (2002) in an introductory organic chemistry course, but in this case a reading assignment from the textbook was combined with an on-line assignment (HWeb) for every lecture. The HWeb consisted of three multiple-choice questions related to the reading assignment. Outcomes of this approach were increased understanding of the material and improved student performance and use of the textbook.

Clearly, the pre-lecture tasks provided students with encouragement for reading the textbook, a recognized excellent educational resource, enabling them to acquire baseline knowledge that could be used to illustrate concepts and enhance comprehension during a traditionally delivered chemistry course.

2.3.1.4 Active and collaborative teaching and learning strategies

The oldest and perhaps the most powerful technique to facilitate active learning is writing which is used by many college instructors in varied ways. A "minute paper" (Paulson, 1999, p.138) is a writing tool in which students were asked to write their reflections about the given question in a few minutes before the end of class. This technique enabled the teacher to assess student understanding of the material just presented. Another writing tool is the journal, which has been used with a high degree of success in many chemistry courses (Kelter et al, 1996; Kovac & Sherwood, 1999). Students kept records of data and expressed their ideas in a journal. According to Kovac (1999), journals promote the development of writing skills and represent the thinking process of a learner. More so, journal entries helped teachers assess what the student understood or misunderstood, especially when exploring concepts that are difficult and complex.

Another simple but common technique that encourages students to be more participative is class discussion. Class discussions are often initiated by questions in class, either from the instructor or from students. Paulson (1999) offered two techniques for a successful class discussion. One is to provide enough wait-time after a question is given to allow students an opportunity to think about the question and formulate an answer (Rowe, 1974; Tobin, 1987). The amount of wait-time depends on the difficulty and complexity of the question. Another technique is to refrain from repeating and rephrasing the questions or answers once they are given. This approach encourages the students to listen carefully to the teacher's question or to their fellow students' answers.

Chemical demonstrations are also a common but significant tool to experience chemistry in action by providing concrete examples of reactions discussed in the textbook. The usual practice is that instructors perform the demonstration while students watch passively. Hatcher-Skeers and Aragon (2002) implemented a General Chemistry course project where college students performed chemical demonstrations as in-class and out-of-class activities. The students found that presenting a demonstration in front of their peers and to high school students in their local community provided them with the opportunity of being the teacher. Having to instruct their peers and the community about chemistry required them to know the material, expand their chemical knowledge and visualization of concepts and plan a presentation strategy. Planning and presentation are skills needed by college students in their careers and could be learned even in a chemistry course.

Large enrolments in introductory science courses provide good prospects for cooperative learning because they offer opportunity to delegate control of the pacing and methods of learning to student groups of two to six members, who work together in and outside of the class. The implementation of group activities vary from one teacher to another. For example, Paulson (1999) used out-of-class group work for lessons that are complicated and mechanistic while in-class team work is predominantly used with activities that involve active learning (Hanson & Wolfskill, 1998). The use of learning teams involves more active students in the classroom. Students working in this format learn more, understand more, remember more, feel better about themselves and others, and have more positive attitudes regarding the course and instructors (Hanson & Wolfskill, 2000; Kelter et al., 1996; Stahl, 1996; Wenzel, 1998). Students also acquire critical thinking skills, cognitive learning strategies and other process skills that are needed in the workplace (Johnson, Johnson, & Smith, 1991). These benefits can be acquired when instructors incorporate elements and strategies in the classroom such as: (a) positive interdependence, (b) individual accountability, (c) promotive interaction, (d) collaborative skills, and (e) self-assessment (Johnson et al., 1991; Stahl, 1996).

2.3.2 Support systems for teacher development

Teachers are the crucial link between the curriculum and students; therefore their professional development is an important element in improving their instructional skills in order to improve desirable student outcomes. The challenge to administrators and to staff developers is to provide and design professional programs that encourage teachers to apply effective teaching strategies and promote teachers' continual learning and expertise. Past and current literature identifies various teacher development approaches to foster pedagogical skills and competencies.

Effective teaching does not simply imply application of a set of rules as stated in general teaching principles but also adapting teaching principles according to one's personal strengths and within one's teaching context. Individual teachers experience various problems and will need to work out their own solutions which may be adapted from generic solutions to their own personality and classroom context. Good experienced teachers continuously collect student feedback about their teaching in order to see the direction of their teaching and whether or not his or her teaching has improved (Mitchell & Mitchell, 1997). Likewise, successful teachers continuously reflect on improving their own teaching practice and ensuring that whatever changes they make, are in the right direction (Biggs, 1999). Reflective practice is considered an essential mechanism for developing teaching practice and for deepening teachers' content knowledge and pedagogical content knowledge. In fact reflective practice is one of the most important ways to develop a personal stock of pedagogical content knowledge (Greenwood, 1991).

In this study the researcher/coach stimulated reflective practice through coaching, small group evaluation of lessons and instructors workshops. Sharing ideas and insights with the coach and colleagues encouraged the teachers to clarify key issues not only in teaching the Chem 4 course but also in unlearning misconceptions and re-learning some chemistry concepts that had been missed in their previous teaching. The coaching process provided opportunities for teachers' reflection and collegial support as teachers dealt with the complexities of students' behaviours in their classrooms and responded to challenges in adapting the phases of the instructional cycle to their own classroom personality and context.

The research summarised by Rhoton, Madrazo, Motz and Walton (1999) identifies approaches that address issues of (a) classroom practices, (b) sustained support for teachers, (c) teachers learning science in new ways, (d) challenges involving pedagogical beliefs and practices, (e) promoting incremental change, and (f) encouraging collaboration. These concerns and issues are addressed within a dynamic and integrated professional development program that employs the principle of context (organizational, systemic and cultural supports needed); content (specific knowledge, pedagogy, skills and attitudes needed; and process (the way content knowledge, pedagogy, skills and attitudes are acquired) (Sparks, 1989).

Loucks-Horsley, Hewson, Love and Stiles (1998) described 15 strategies for professional learning. The implementation of each strategy considers (a) some underlying principles such as knowledge and beliefs about teaching and learning; (b) key components of the strategy; and (c) resources and support needed to implement the strategy. Three of the 15 strategies are described in this review because they also contribute to the framework for the teacher development process implemented in this study. These strategies are (a) curriculum development and adaptation, (b) workshops and seminars, and (c) study groups.

2.3.2.1 Curriculum development and adaptation

Curriculum development is the production of content-based material for implementation in the classroom (Loucks-Horsley et al., 1998). The content-based material contains a subject matter matrix that identifies concepts and themes intended for a specified level of students. The course material is also a guide for teaching the course. The process of implementing the course material and modifying it to meet the needs of students, teachers and the University/Department constitutes the curriculum adaptation. The development and adaptation of course material provides the teachers with opportunities to increase their content and pedagogical knowledge and to learn from the expertise of colleagues or others.

2.3.2.2 Workshop and seminars

Workshops and seminars are structured opportunities usually conducted by facilitators, leaders or peers with specialized expertise, in an out-of-classroom location and over a short period of time. The participants' experiences and learning during a seminar-workshop are facilitated by using a training model that employs these steps: explanation of theory, demonstration or modelling of a skill, practice of the skill under simulated conditions, feedback about performance and coaching in the workplace (Showers & Joyce, 1996). The goals of a seminar-workshop are (1) to provide the instructors with new experiences and insights into the actual implementation of the course so they can take these strategies to their classroom; (2) provide the instructors with a forum for sharing their ideas and for receiving feedback to improve the new course; and (3) forge new collaborations aimed at developing the course material to improve the teaching and learning process.

In the Philippines, teacher-training programs are conducted through seminars, workshops and short courses that are funded by either government science and education agencies or private foundations. Summer courses, typically of six weeks duration, include courses in elementary science, elementary mathematics, high school mathematics, high school physics, high school chemistry, college science courses and a special course for engineers interested in becoming science teachers. Certificate courses are of two types. One type are those courses geared towards the needs of high school teachers who do not have the appropriate pre-service qualification to teach Chemistry and Physics. These courses run for three semesters with the main focus on the strengthening of subject content knowledge and little attention to teaching strategies. The other type of courses are purposely offered to college science instructors who have been teaching without the appropriate content and pedagogical knowledge. The training is given for two semesters and those instructors who qualified for a postgraduate degree are given the opportunity to complete a master's degree. However, there was no rigorous follow-up, even on a school level, of the practices or effectiveness of teachers who had undergone the training (Somerset, 1998).

In this study, the primary focus of the summer workshop was to introduce instructors to reform initiatives that shift the focus of the classroom from the teacher conducting alecture throughout the session, to a classroom where students are engaged in in-class activities while the instructor continuously assesses student performance. In a General Chemistry workshop conducted at Stony Brook (Hanson & Wolfskill, 1998) similar goals were articulated but with more emphases on complex processes such as team learning, guided discovery, critical thinking, problem solving, reporting, personalized assignments and assessment into a coherent package.

2.3.2.3 Study groups or discussion groups

Study groups provide teachers with opportunities for an ongoing system for discussing, reflecting on, and analysing their implementation of strategies. The success of study groups depend on the commitment of the teachers to reflect on their work and take the initiative for their own learning as they investigate content, instructional practices, and student learning.

The approach proposed by Bell and Gilbert (1996) encompasses three areas of development for teachers — professional, personal and social. Development of these areas is viewed as interactive and interdependent that is, development cannot proceed in one aspect without developing the others. This approach is conceptualised from a social constructivist perspective, where learning is seen as taking place within the social contexts of the classroom and the wider context of society. This approach could provide a theoretical framework for initiating collaborative ways of working, one of the concerns of this study. However, the model was not adopted as a framework for the teacher development described in this study because it provides a complex conceptualisation of science teacher professional development that could not yet address the current status and needs of the instructors at the University of San Carlos.

Another approach, which this researcher found practical and applicable to this study, is the teacher development model conceptualised by Beeby (1980) and modified by Berg and Saniel (1996). Beeby classified teachers into unskilled, mechanical, routine and professional. Unskilled teachers lack sufficient background of the subject matter they teach, have inadequate knowledge of teaching methods and are poorly motivated. Mechanical teachers are those with enough subject matter mastery but who teach the subject matter with one teaching method only. The routine teachers have good subject matter mastery, even beyond the requirements of the curriculum and have an adequate repertoire of teaching methods. This group of teachers may or may not be involved in teacher development but they are interested in improving student performance. The professional teachers are well trained, have good subject matter mastery, a wide range of teaching repertoires and are active in improving their own teaching. This category of teachers is interested in improving student learning, thus they involve themselves in professional endeavours such as revising course materials, trying-out new approaches, reading journals and attending conferences.

The four classifications of teachers were used by Beeby as the basis to conceptualise a four-stage development process for teachers. The growth process moves from unskilled, to mechanical, routine and professional phases. This model is significant to the current study as it provides a viable framework for identifying the status and conditions of the instructors involved, thereby enabling use of the coaching model as a practical and sustainable approach to facilitate long-term teacher behavioural changes that improve instruction.

2.3.2.4 Coaching teachers for success in the classroom

As described in previous sections, an effective teacher alternately and simultaneously exhibits varied roles as planner, manager, evaluator, diagnostician, facilitator, innovator, model, decision maker, experimenter, guide and source of knowledge. To fulfil these roles, teachers must be supported by a training program that provides opportunities to change their attitudes and behaviours, to enrich their knowledge and expand their teaching skills (Dori & Barnea, 1997). The coaching approach has a strong research base for helping teachers reduce isolation, use innovations in a practical way, and learn new behaviours that contribute to student learning (Joyce & Showers, 1982).

For example, Showers (1985, p. 47) stated that "coaching provides a safe environment in which to learn and perfect new teaching behaviours, experiment with variations of strategies, teach students new skills and expectations inherent in new strategies, and thoughtfully examine the results." Similarly, Robbins (1991) indicated that coaching enabled the teachers to reflect upon current practices, make some fine tuning of these practices and expand their teaching capabilities. Likewise, peer coaching facilitates the exchange of teacher methods and materials and provides a mechanism by which teachers could receive more regular feedback for their classroom performance without fear of being evaluated by a supervisor or head of school (Munro & Elliot, 1989). Instructional sharing, when done regularly, fosters collaboration and creates a more positive collegial atmosphere (Horn, Dallas, & Strahan, 2002).

Other significant outcomes of peer coaching include successful implementations of new teaching pedagogical strategies (Munro & Elliot, 1989). Improvements in students' academic skills and competencies were attributed to the newly developed techniques of teachers who are engaged in coaching (Sparks & Bruder, 1987). Likewise, Kohler, Crilley and Shearer (1997) used a multiple-baseline design to examine the effects of peer coaching on teachers' implementation of an integrated instructional approach at the elementary level. Four results were reported: (1) all the teachers involved made few changes or modifications in their instructional approach during the initial baseline condition. However, with peer coaching teachers made procedural refinements in their approach; (2) many of the changes instituted during coaching were sustained in a follow-up or maintenance condition; (3) the instructional activities were associated with a variety of different teacher and student processes; and (4) all the teachers expressed varying degrees of concern and satisfaction. These results implied that coaching enabled teachers to develop, refine and sustain their use of strategies that address student's diverse learning needs and capabilities.

Ackland (1991) identified two coaching models. Expert coaching is more of a consultative model whereby professionals with specific expertise observe teachers and give them feedback and recommendations, while peer coaching involves teachers observing one-another and giving specific feedback on teaching behaviours that need enhancement (Joyce & Showers, 1982). Coaching as described in this study was a method of improving teacher effectiveness, whereby teachers worked with a more experienced colleague to achieve specific instructional goals through a process of regular observation and on feedback. An on-site coaching approach was adopted where each coaching segment consists of a pre-observation conference, an observation and a post-observation conference (Leggett & Hoyle, 1989).

2.4 Summary

The literature review identified some factors that are considered to increase learning. Among these factors, instruction is the one that can be altered by teachers. The basic task for the teacher is to develop a smoothly running classroom community, where students are continuously involved in worthwhile activities that support learning. This situation calls for an effective management system. To attain this goal, curriculum materials must be aligned with teaching styles and the teachers must be properly supported in acquiring desired teaching behaviours. When changing a basic teaching method, teachers have to develop new teaching skills. The shift from lecturing to applying the instructional cycle described above might seem like a relatively small change. Yet it is a huge step for teachers who have permanently used a lecture approach for over 10 years. The traditional approach to changing teaching methods has been to organize an in-service course. However, many authors have pointed out that in-service alone is not sufficiently effective. Teachers need in-classroom support through coaching by peers or experts who observe their teaching and interact constructively with them to improve their teaching. Coaching (peer and expert) enables teachers to collaborate in developing, implementing and refining practices that maximise student performance in and outside the class. A growing amount of research indicates that coaching promotes changes in teachers' pedagogical practices, improves teachers' ability to plan and organize classroom activities and use effective teaching behaviours, and enhances teachers' ability to employ classroom behaviour management strategies. That is why coaching was made into a key-component of the course and faculty development project.

CHAPTER 3
METHODOLOGY

3.0 Overview

This chapter describes and explains the methods used by the researcher in answering the research questions stated in Chapter I. The chapter is divided into four sections: rationale for the methodology used in this research, background information, data collection and data analysis. The first section examines theories related to research methodological underpinnings in order to justify the use of a qualitative interpretive case study as the research design for this project. Issues addressed in this section include interpretive research methods, multiple methods, internal validity and case study design. The second section, background information, is a description of the research locale, the reconstructed course, the participating instructors and students involved in the study. The third section provides the description of the four stages of data collection and the qualitative and quantitative instruments used in the study. The methods in analysing the data obtained are described in the fourth section. Finally, the chapter ends with a summary.

3.1 Research Methodology

It is widely acknowledged that science teaching depends on the teacher's frame of reference that includes beliefs, cultural, social, education and skills, and that this can be influenced by good and effective teaching practices that are either informed through research or through professional development programs. Several teaching methods are known and have been effective for improving learning in science both in high schools (Fraser et al., 1987; Rosenshine, 1987) and at college or university level (Biggs, 1999; Leonard, 1997; Peterson, 1979). Walberg (1991), in his syntheses of large scale educational research studies, identified nine factors that appear to increase learning. It is also recognized that the bulk of work of science teachers is generally focused on discourses in the classrooms, between teachers and students, or among teachers, students and other persons in the educational arena. Understanding the ecology of classroom discourses and detailing events in the classroom requires a research method that would allow science teachers and researchers to freely express and communicate their beliefs, personal experiences and interpretations about their social and cultural environment.

A qualitative interpretive case study is a research format that provides a bounded system through which teaching and learning outcomes for the new Chem 4 course are identified and studied. This research is interpretive because it utilized a methodology format of enquiry that guides the researcher to investigate phenomena relating to teachers' current classroom practices and describes the processes in which the teachers are adopting new teaching schemes following an intervention. Such approaches allow the researcher to gain insights, discover and make interpretations in addition to testing hypotheses (Merriam, 1998). This approach to research "permits us to learn about the thinking, beliefs, and values of science teachers, and others both within and outside the educational community who influence the milieu in which science teachers work" (Gallagher, 1991, p. 6).

In an effort to use this research to improve teaching, the concern of the researcher was not solely to search for the general characteristics of effective instructors in the Department so that other instructors can learn these behaviours and apply them in their classroom. Rather a large part of the researcher's interpretive role concerned observing, interviewing and videotaping instructors in their classrooms to see the day-to-day happenings in the classroom for each teacher with a particular group of students within a certain period of time. It was interpretation of these observations that informed the intervention based on the model of Showers and Joyce (1996). The researcher sought to introduce specific details of classroom actions that constituted effective teaching and learning that can occur between teachers and students as well as among students.

3.1.1 Interpretive research methods

Interpretive research methods can be adapted for use in educating teachers (Cronin-Jones, 1991). Reflecting upon beliefs about teaching and learning practices, writing journal entries to describe and interpret science teaching and learning events, using and critiquing the course material, and reflecting upon chemistry lessons with peers and students are experiences that are incorporated to make meaning out of the situation being researched.

Research within this methodological framework suggested a number of properties that defines the research (Lincoln & Guba, 1985). These properties include natural settings, human instruments, qualitative methods, emergent design, negotiated outcomes and case study reporting. Even though each of these characteristics is viewed as a separate entity, each is dependent on each other in determining a complete conception of the research being undertaken.

Gallagher (1991, p.15) describes interpretive research as a "tool for helping science educators in universities gain a better understanding of the community into which educational products move." By products, he meant not only the teaching force but also programs and models for teaching and learning science, and the materials that are produced to support teachers' work with students. Furthermore, interpretive research is a tool for helping all those who are teaching regardless of the level (university, high school or elementary) to gain a better understanding of the many facets of teaching and learning.

The information derived from this study demonstrates the quality and usefulness of these methods and the variety of ways in which they can be adapted to different situations. For example, the instructional cycle model and the classroom performance of the different instructors are all informative and useful in illustrating the different set of actions and interpretations to define effective teaching and good classroom management.

3.1.2 Case study

Within the context of case study research, the researcher selected an approach that is exploratory and descriptive in nature (Marshall & Rossman, 1995). The intention is to explore how the instructors are adopting the instructional cycle model into the chemistry course and to describe the processes undertaken during the adaptation. Case study research as described by Merriam (1998) is particularistic which means a focus on one phenomenon, descriptive which provides a rich illustration of that phenomenon, and heuristic which is further investigation of the phenomenon.

Applying Merriam's description, this study's particular focus is centred on each instructor adopting the new teaching model while refining and/or acquiring basic teaching skills. The research is descriptive because the end result attempted to portray a rich illustration of each instructor's classroom practices and identify students' perceptions and explain the interrelelationships of these data. Likewise, the research is heuristic because it serves as a signpost to instructors within the university and other teachers interested in changing their classroom practices.

Sjoberg, Williams, Vaugham and Sjoberg (1991, p.32) proposed five goals that may be addressed by case study research. These goals are (1) furthering scientific analysis by introducing a negative (deviant case); (2) investigating what is beyond the boundaries of reasonableness by using an extreme case; (3) supplementing reductionism of analytic research by a holistic perspective; (4) providing social minorities with a voice; and (5) describing cases that have special importance, for instance, ones that may be believed to anticipate future social changes.

Yin (1994, p. 13) defines a case study as " an empirical enquiry that investigates a contemporary phenomenon within its real life context". In this study, the contemporary phenomenon is the instructors' adoption of the instructional cycle model within the real-life context of the Chem 4 course. The study falls into the category of a collective case study (Stake, 2000) because the researcher used several cases jointly in order to inquire into the phenomena of instructors' adaptation to the new teaching model. Individual cases were chosen in order to lead to a better understanding of a large collection of cases (Stake, 2000) and each case was expected to show common characteristics that could be used to understand the whole situation. Making a grand generalization is not the intention of the researcher, but as Firestone (1993) suggests in his case-to-case studies, it is the researcher's responsibility to provide a description of each case that is sufficient enough in detail to enable the readers to transfer understandings from one case to another. Thus, the generalizations made in this study are small steps toward an understanding of the processes that the instructors undertook in changing their classroom practices.

Employing qualitative interpretive case study research methods connotes some problems, one of which is the fundamental political nature of interpretive research methods. The researcher makes choices about what questions are and are not asked, the people who are and are not included in the research, the types of data that are and are not collected, how data are collected and the ways of making sense about the data, and giving credence to or questioning the credibility of various forms of evidences of the inquiry process. Each of these choices has profound political contours. Erickson (1986) pointed out that inadequate variety and amounts of evidence, faulty interpretative status and inadequate disconfirming evidence are criteria that need to be addressed during data collection. Likewise "data that are filled with hearsay and overgeneralizations and are lacking in specifics are weak" (Biklen & Bogdan, 1986, p. 95). These criteria can affect the validity and generalizations drawn from a study. Validity of a case study is based on the relationship between the general and the individual—the nature of the difference between a consensual worldview and the specifics of a case study.

Despite these issues, researchers using qualitative interpretive case study methods are making unique contributions which not only generate new knowledge, but which can also potentially benefit the participants in the study through increased self-knowledge, emphatic relationship and positive behaviour change.

3.1.3 Validity and reliability of case studies

Three basic ways of validating qualitative research are "through innate and universal reasonableness, through a universal trial-and–error learning, and through the use of pluralistic epistemologies" (Polkinghorne, 1983, p. 244). In this study, the pluralistic epistemologies were applied in the form of multiple sources of evidence in order to allow the investigator to address a broader range of issues and to allow for the development of "converging lines of inquiry" (Yin, 1994, p. 92). The multiple sources of data collection included classroom observations conducted by the researcher, instructors, supervisor, associate supervisor and a content expert colleague; videotapes of classroom teaching, audio-taped semi-structured interviews of students, instructors' journal records, questionnaires and the researcher's own journal records about the coaching conferences, small group discussions and monthly meetings with instructors. In case studies, reasonableness and persuasiveness are important ways to validate interpretations such that there is meaningful agreement of all the data in general within the broad context of the research.

There are two main approaches to increase the reliability of a qualitative research. The first approach, triangulation, is based on independent actions with the ultimate comparison of all results. The second approach is internal consistency (Cohen & Manion, 1994).

Triangulation is based on the idea that if several independent different actions give similar results, the results will have higher reliability. Stake (2000) further confirms triangulation as a method of increasing the reliability of a case study. Cohen and Manion (1994) identified six types of triangulation: theoretical triangulation when various theoretical frameworks are used; data triangulation based on using different sources of data; investigator triangulation when research is conducted by several independent researchers; methodological triangulation based on the utilization of different methods of research; time triangulation which takes into consideration the factors of change and process; and space triangulation which attempts to overcome the parochialism of the study conducted.

Data triangulation in this research included the use of different data collection modes (observations, interviews, questionnaires, journal records and videotapes of classes). Independent persons, member checks and peer examination are the means utilized for other people to view the results of the study. Three independent and competent observers viewed all the videotapes of classes, tallied the time logs and noted down salient features and patterns observed in each class. A video-coding matrix developed by the researcher was provided. Member checks involved the researcher presenting the data (students' perceptions) to the participant instructors and requesting them for their comments and confirmation to determine the plausibility of the data. Peer examination involved the observation reports made by the supervisor, associate supervisor and a content expert colleague as well as observations made by the Department Chairperson. All these contributed to the reduction of subjectivity bias and increased the reliability of the data collected.

Similar to data triangulation, internal consistency is based on the idea that the parts of the whole amount of data are analysed and the results of the analysis of different fragments of data are compared with each other. The data analysis is done in sequential order when a researcher develops hypotheses based on previous data and verifies them by following-up data.

3.2 The Research Setting

The study was conducted in one of the Southeast Asian countries, the Republic of the Philippines. Students in the Philippines enrol in six years of elementary school followed by four years of high school; college (university) starts after 10 years of schooling. The science curriculum follows an American model. In high school, first year students take General Science which consists of some Physics and Chemistry and much Earth Science; in the second year students take Biology, in the third year Chemistry and in the fourth year Physics. Some special science schools and some private schools deviate from this pattern and offer Advanced Biology, Advanced Chemistry and sometimes Advanced Physics. In college/university, the first two years are occupied with general introductory or liberal education studies; Introductory Chemistry is one of the courses taken. In the third and subsequent years, students take a range of major courses. Chapter 2 provided a brief description of the quality of science teaching in the Philippines.

3.2.1 The University of San Carlos

The University of San Carlos (USC) is located in Cebu City, the capital of the Province of Cebu in the Southern Philippines, some 500 kilometers from Metro Manila in Luzon. Cebu City is the second most industrialized centre in the Philippines and is also the centre of education and culture in the south. The population of the Cebu metropolitan area, including Cebu City, Mandaue City and Lapulapu City, is about 1.2 million inhabitants.

The university is administered by the Society of the Divine Word (SVD), a Roman Catholic missionary order. It has four separate campuses: the Main Campus at P. del Rosario Street (Social Sciences and Humanities, Commerce, Graduate School, central Library, Student Services Complex and SVD Community Building); the Teacher Education Center Campus (Elementary and Secondary Schools for Girls, College of Education, College of Nursing and the Cultural Center); the Boys' High School Campus (Elementary and High School) and the Talamban Campus, some ten kilometers north of the city (Lawrence Bunzel Technological Center, Arnold Janseen Science Building, Office of the Population Studies, Water Resources Center, Science and Mathematics Education Institute, University Church and the Seminar-Retreat

House). The Chemistry Department, where the research was conducted, is located on the Talamban Campus with the other science departments.

Presently, the university administers nine colleges/faculties, namely, Arts and Sciences, Commerce, Engineering, Architecture and Fine Arts, Education, Nursing, Pharmacy, Graduate School and Law. The university has a population of 15,764 college students as of semester 2, 2000, and a total population of 21,386 for the academic year 2000-2001, including elementary and high school students. The Commission on Higher Education (CHED) declared the university as the centre of excellence for teacher education and centre of development for the sciences. This obliges the university to conduct outreach programs for instructors of other universities in the Visayas and Mindanao. The university has an academic linkage with The Netherlands Universities' Foundation For International Cooperation in Higher Education (NUFFIC).

The College of Arts and Sciences has 14 departments which offer general academic courses for the other colleges. This College provides undergraduate courses in science with chemistry courses handled by the Chemistry Department. The researcher belongs to the Chemistry Department of this college, and one of the service courses offered here was the focus of this research, namely Chem 4.

3.2.2 The Chemistry Department

Faculty members in the Chemistry department teach all the chemistry courses offered in both undergraduate and graduate levels either as service or major courses. Chemistry service courses are given to the students of other colleges such as engineering. There are eight general chemistry courses in the department, numbered as 1a, 2a, 1e, 1, 4, 11e, 11 and 14. These courses have a descriptive title such as General and Inorganic Chemistry with content depending on the curriculum of the students and each is accompanied by parallel laboratory sessions. The letter written after a Chemistry course number is used to identify the introductory chemistry course in which a particular student will enrol. For example, Chem 1a is a one-semester introductory Chemistry course for Arts and Social Science students while Chem 2a is for Pharmacy, Biology, Mathematics/Computer Science, Nutrition and Nursing students. The Chemistry majors have Chem 1 and 11 as their introductory Chemistry courses, the Physics-Chemistry teacher education students take Chem 1e and Chem 11e, while the engineering students take Chem 4 and 14.

A chairman heads the Department and is in charge of 23 instructors, 16 of whom are employed full-time. At the time of this study there were six doctoral degree holders in chemistry, seven masters' degree holders and ten bachelors' degree holders. Several PhD holders in the department obtained their degrees abroad in Austria, Japan and Australia. However, the BS and MS degrees are local and below international level as can be seen from the time it takes to obtain them. A BS in the Philippines requires 6+4+4=14 years of schooling, while in the USA it takes 6+6+4=16 years of schooling. Furthermore, the quality of the 14 years of schooling is less than that in high-income countries.

Fifty percent of the faculty has more than and 50% has less than 10 years of chemistry teaching experience. Six faculty members teach chemistry courses for chemistry majors while the other 16 faculty members teach the service courses only, that is, the various versions of the General and Inorganic Chemistry course. The minimum teaching load of a full time faculty is 24 hours per week and the maximum is 27 hours per week. Each faculty member is required to be available for 10 hours per week for consultation of students, meetings and other co-curricular activities in the Department. The laboratory staff are either licensed chemists or chemical engineers whose task is to provide support to the teaching faculty, particularly in the preparation of the reagents and materials needed in both lecture and laboratory sessions.

3.2.3 The course

Chem 4 has the descriptive title of General and Inorganic Chemistry I and is regularly taken by first year engineering students during the first semester. In semester two, students who failed the course in semester one, transferees and irregularly enrolled students usually take the course. Students in Chem 4 are expected to have a satisfactory background of high school chemistry and mathematics, but this is generally not the case as was discussed in Chapter 2. The content outline of the first semester Chem 4 is listed in Figure 3.1.

Main Subjects		Sub-Subjects
I. Introduction	1.1	Scope of chemistry
	1.2	Usefulness of chemistry
	1.3	Chemical technology
	1.4	Branches of chemistry
II Forms Of Matter	2.1	Properties of matter: physical, chemical, intensive, extensive
	2.2	Classification of matter: substances, mixtures; elements, compounds; homogeneous (solution), heterogeneous; metals, nonmetals, semi-metals
	2.3	Methods of separating components of mixtures: physical means (filtration, evaporation, centrifuge, decantation); other means: distillation, chromatography
	2.4	Changes of matter: physical and chemical changes
III. Atomic Structure And Periodic Table	3.1	Dalton's atomic theory: laws of chemical change, experimental basis for subatomic particles (electrons, protons, neutrons, isotopes)
	3.2	Models of the atoms: Thomson, Rutherford, Bohr, dual nature of matter, Schroedinger model of the atom
	3.3	Quantum mechanics: quantum numbers (H to Ne), energy levels, orbital, electron configuration, valence electrons, differentiating electron, orbital diagrams, diamagnetism, paramagnetism
	3.4	Organization of elements: s, p, d, f blocks of elements, abbreviated electronic configuration, group properties, trends in properties (atomic size, ionization energy, electron affinity), effective nuclear charge
IV. Chemical Bonding	4.1	Formation of ions: cations, anions, noble gas configuration, electron configuration of ions of the representative elements
	4.2	Different types of substances: different properties, three types of bonds
	4.3	Metallic bond: properties of metals (malleability, ductility, electrical and thermal conductivity)
	4.4	Ionic bonding, lattice energy (relate to ionization energy and electron affinity), properties of ionic compounds, non-directional bonds, names and formulas of ionic compounds
	4.5	Covalent bonding: properties, names and formulae of molecular compounds, Lewis structures, electronegativity, names and formulas of molecular compounds, multiple bonds, polarity of bonds

V. Chemical Equations And Stoichiometry	5.1	Atomic and molecular weights: percentage composition from formulas, mole, molar mass, empirical and molecular formulas
	5.2	Writing and balancing equations: types of chemical reactions (combination, decomposition, displacement, double replacement, combustion)
	5.3	Decoding chemical equations: quantitative information from balanced equations, mole-mole, mole-mass and mass-mass relationship
	5.4	Stoichiometric calculations: limiting reactant, theoretical yield, per cent yield
	5.5	Practical uses of stoichiometry
VI. Gases	6.1	Properties of gases: compressibility, viscosity, surface tension, role of some gases in atmospheric chemistry (greenhouse effect, ozone depletion)
	6.2	Kinetic molecular theory: basic gas relationships
	6.3	Gas laws: Boyle's law, Charles's law, Amontons' law, Avogadro's law, ideal gas law, Graham's law of diffusion\effusion, Dalton's law of partial pressure, GayLussac's law of combining volumes
	6.4	Stoichiometry involving gases: gas densities and molar mass, volumes of gases in chemical reactions
VII. Intermolecular Forces, Liquids And Solids	7.1	A molecular comparison of liquids and solids: properties of the different states of matter
	7.2	Intermolecular forces: dipole-dipole, London dispersion forces, hydrogen bonding
	7.3	Geometry of molecules: VSEPR (up to tetrahedral), polarity of molecules
	7.4	Phase transitions: properties of liquids (viscosity, surface tension, vapour pressure, melting point, boiling point) phase diagram, critical point, freezing point, triple point; properties of solids, types of solids
VIII. Energetics	8.1	Nature of energy: heat, temperature, system, surrounding
	8.2	The first law of thermodynamics: endothermic, exothermic, state functions, internal energy, enthalpy
	8.3	Calorimetry: heat capacity, specific heat, calorie, bomb calorimetry, foods and fuels (caloric intake and energy expenditures)
	8.4	Hess's law: enthalpies of formation, enthalpies of Reaction

Figure 3.1

Content outline of the first semester Chem 4 course

The course is four units of credit, being three units of credit for the lecture and one unit of credit for the laboratory work. The grades in the lecture and in the laboratory are treated separately. The lecture session is three hours per week scheduled as one hour per session each day on Monday, Wednesday and Friday (MWF) and 1.5 hours if the class falls on Tuesday and Thursday (TTh). The laboratory part is a single three hours per week session with the students. This study focused on the lecture part of the course. The laboratory part will be researched in a future project.

3.2.4 The instructors involved in the study

Seventeen out of 27 instructors of the Chemistry Department at USC were involved in this project, with nine instructors being involved during the pre-project stage. Two instructors, each of whom was recommended by the Department chair, were involved in the initial implementation of the new Chem 4 course but they were not involved in the pre-project stage because they were not teaching Chem 4 during that time. These two instructors conducted the first version of the course from November 1999 to March 2000 in the university. One instructor is a young female, a Masters degree candidate with five years of teaching experience. This instructor also conducted the Chem 4 class in April-May 2000 when colleagues took turns in visiting her class; she continued teaching Chem 4 until June-October 2000 to a section of chemical engineering students. The other instructor is male, middle-aged, and a Masters degree holder with 11 years of teaching experience. Both are full time instructors, licensed chemists (Philippine BS Chemistry holders are licensed through a national examination), and had participated in a three week course development workshop in which they prepared course material for Chem 1a and Chem 14, respectively.

The final stage of this study involved 13 instructors, six of whom were involved in the pre-project stage. Only one of the 13 instructors was involved in the pilot implementation and six instructors were involved only in the final stage. The three instructors who were involved in the pre-project stage and the instructor who was involved in the pilot implementation were not involved in the final stage because they were not teaching Chem 4 at that time.

All the 17 instructors involved in some aspects of this study had teaching experiences ranging from those in their first semester to 25 years of teaching. Five of these instructors are male and 12 are female. The educational qualification profile of the instructors teaching Chem 4 courses at the time of the study is presented in Table 3.1.

Table 3.1

Educational qualification profile of Chem 4 instructors

Degrees Attained	Number of Instructors
Doctor of Philosophy in Chemistry (Austria)	1
Master of Science in Chemistry	3
Master of Arts in Teaching Chemistry	4
Bachelor of Science in Chemistry	9
Total	17

3.2.5 The students

First year students from Chemical, Civil, Electrical, Computer, Industrial, Mechanical and Electronic Communication Engineering were the students of this project. At the start of this study, there were two classes of Chem 4 in semester 2 for the academic year 1999-2000. One class, the MWF group, had 54 officially enrolled students of whom 50 students took the midterm/final examinations and were regular attendees in the class. Thirty-two students (59%) were repeating the class while 22 (41%) were taking the course for the first time. Of the 32 repeaters, two students had taken the course twice already, one student had taken it thrice and one had repeated the course four times. The reason for having so many repeaters is that most students take the course in semester 1. Students who take the course in semester 2 are out of phase or are repeaters.

The other class, the TTh group, had 55 officially enrolled students but only 43 took the midterm/final examination and were regular attendees in the class. One student had officially withdrawn from the course; four students did not attend the course at all and seven students attended 2-5 sessions only and did not continue with the class. Of the regular attendees, 22 (51%) students were repeaters, while 21 (49%) were non-repeaters.

In summer 2000, the only Chem 4 course taught comprised a mixed class of students from Pharmacy, Computer Science and Engineering. There were 47 officially enrolled students in this class but only 43 were regular attendees; one student did not attend and three had withdrawn from the course after a week of attending the class. Most of these students (80%) were repeaters and 20% were transferees from other colleges within the University of San Carlos and transferees from other universities.

During semester 1 of the academic year 2000-2001, there were 15 classes of Chem 4. Almost all students in these classes were new freshmen between the ages of 16-17 years. The number of students in each class ranges from 43-55. Fourteen classes were included in this study and one was excluded because it was used as a pilot class for the integrated lecture and laboratory course. Thirteen instructors taught the 14 classes; only one instructor was assigned to two classes. There were 741 officially enrolled students in these 14 classes but the total regular attendees were 702; eight students had officially withdrawn from the course and 22 students dropped the course. Students who withdraw from the class make an official notice to the university by filling up and submitting the required forms while students who miss classes for three consecutive weeks without prior notice are considered dropped from the course.

3.3 Data Collection

The purpose of this study was to start a process of course and faculty development that aimed at increasing the learning performance of students within and outside the classroom. There were four stages in the data collection. The initial stage was the assessment of the current General Chemistry teaching in USC where observations and videotaping of the course and instructors were conducted before the reconstruction project. The second stage included the Chem 4 course reconstruction and a pilot study in the classes of two instructors. The third stage was the revision and pilot of the second version of the course in one class with other instructors observing sessions of the course, and preparing the third version. The last stage was the implementation and evaluation of the version 3 of the course in 14 classes of Chem 4 by 13 different instructors.

The first stage involved the observation and assessment of teaching and learning prior to the implementation of the reconstructed course. Nine instructors were observed and for each instructor two of their class sessions were video-recorded. Three instructors had the initial videotaping of their classes in February 1999 while the others had them between November 1999 and March 2000. The first videotape was unannounced which meant that the instructor was not notified of the video recording; for the second videotaped session, the instructors' choice and preferences were sought. The unannounced video recording captured the average day-to-day teaching while the announced recording may show best teaching as perceived by the instructor concerned. Each researcher's observation data were recorded in a journal and two videotapes of teaching for each instructor were transcribed and compared.

The second stage was the course reconstruction and the pilot implementation in two classes with two instructors. The preparation of the course material for Chem 4 was done between October and November 1999 during a course development seminar-workshop conducted by a Dutch consultant who was an expert in curriculum development. The seminar provided valuable and useful input on the basic teaching schemes that had to be included in the revision of the course. Course material was reconstructed to apply a instructional cycle approach in which each class meeting consisted of one or more cycles of three phases.

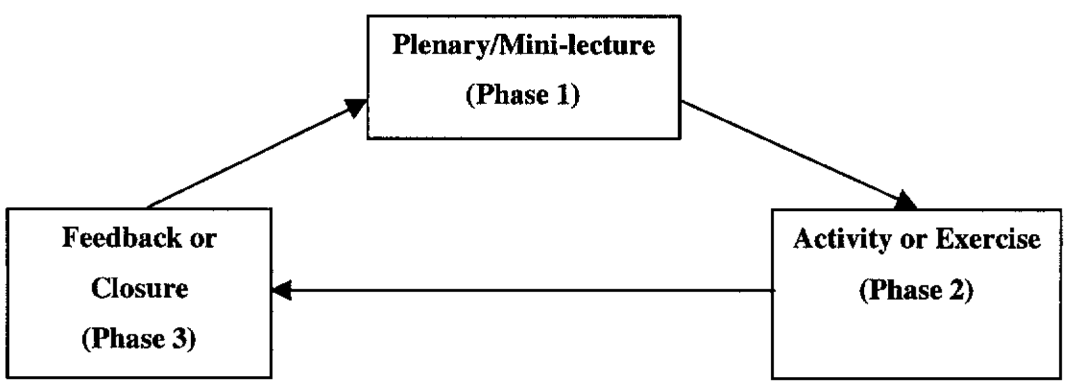

Figure 3.2
Three phases in the instructional cycle used for reconstructing the course material for Chem 4

Two instructors, assisted by the researcher who acted as coach, taught the first version of the course. The three phases of the instructional cycle, shown in figure 3.2, were implemented in almost all class meetings of semester 2, academic year 1999-2000. The first phase was a short plenary or mini-lecture which included a short presentation of new information. The second phase was an activity/exercise where students worked on problems, questions, or activities with the instructor moving around the classroom. The third phase was closure of the lesson or a summary that included reactions to learning difficulties encountered by the teacher during phase two.

During phase two, the instructor interacted with the students either individually or in small groups and identified any problems that the students experienced with the new subject matter. Common errors and misconceptions and other feedback were used in the third phase. Learning about students' difficulties was an essential part of the course improvement process and the professional development of the instructors. In practice instructors did not use the cycle in a dogmatic way from phase one to phase three. Sometimes an instructor started with a seatwork (phase two) and then moved to phase three and then one.

The researcher attended almost all lessons in the two classes, sometimes team-taught with these instructors and assisted them through coaching, to help develop the special teaching skills needed in this approach. Journal recording, videotaping of teaching, which started at this stage, and student interviews were conducted. The course materials were subsequently revised and used again in the summer classes.

Stage three of the study included the revision and pilot of the second version of the course in one class, with other instructors observing sessions of the course, and preparation of the third version. The revised course material (version 2) was used in April-May 2000 by one instructor in a pilot study. Twenty instructors in the Department attended one of the six weekly sessions in small groups to observe the teaching method. These instructors also participated in a weekly training session and in the second revision of the course which involved all the activities and homework because the Department decided to use a new course textbook. The 1997 edition of *General Chemistry* by Theodore Brown replaced the 1986 edition of *Chemistry* by

Charles Mortimer. Answer keys to all the activities, assignments and problems were included in the course manual for teachers. A colleague with a doctoral degree in Chemistry checked the content organization and clarity of the subject matter included in the course. The output in this stage was the second revision of the course material. Field-notes during small group discussions, class observations, and workshops were documented by the researcher.

The fourth and final stage of the study was the departmental implementation of the third version by 13 instructors in 14 classes. In semester one of academic year 2000-2001, 13 instructors in 14 parallel classes implemented the second revision of the course. The researcher, together with a content expert colleague and the associate supervisor regularly observed these 14 classes, gave feedback and provided assistance to the instructors after each class visit. During September, 2000 the supervisor visited and observed some of these classes for one week and made a report about his observations (Treagust, 2000). In some classes where the instructor was less confident in implementing the new approach, the researcher team-taught with the instructor. The instructors participated in weekly sessions on implementation problems in small groups with the researcher, and in monthly sessions with all instructors. Peer observation also was conducted to continuously monitor the progress of each instructor not only in terms of routine behaviours, but also in terms of their pedagogical content behaviour. Accounts of these activities were recorded by the researcher in a journal. Likewise, videotapes of teaching were taken for each teacher and later transcribed.

Feedback from the students, instructors, supervisors, associate supervisor, the content expert colleague and the researcher was consolidated for making necessary recommendations for the continued implementation and monitoring of the instructional cycle. These recommendations were not only for Chem 4 but also for other Chemistry courses and Mathematics courses where the instructional cycle was introduced. These different methods and stages of the study are summarized in Table 3.2.

3.3.1 Sources of data

Qualitative and quantitative approaches were adopted to describe the course and faculty development process. The qualitative approaches included announced and unannounced videotapes of teaching of 17 instructors before and at various times during the project; records of classroom observations and instructor meetings; interviews with students and instructors; instructors' journals and the researcher's own journal record. The field-notes, as in this research, contained descriptions of the setting, people, activities undertaken, direct quotations and the observer's own comments (Merriam, 1988).

3.3.1.1 Video records

Instructors' and students' actions are a complex system of behaviours and it is difficult to follow through with few observations. Videos can help capture complexities of fast-paced classroom interactions between the students and instructor and among students. "Documentation of teacher performance and skill attainment gathered in a technologically objective way, like the videos is more precise than the data gathered using traditional methods" (Eckart & Gibson, 1993, p. 288). Viewing videotapes of a teaching episode provided accurate visual and verbal evidence of the actual performance. Aside from that, videotaped lessons were played and replayed so that classroom details such as class time be determined. Optimal use of class time was an important aspect in this study. The videotaped classroom performance enabled the researcher to keep logs of actual class time, wasted time and time spent in the plenary, seatwork activity and closure or summary phases and other activities performed in the classroom. The time logs provided the researcher with an overview of the quantity of time devoted to each phase in the instructional cycle model that was missed during classroom observations.

Table 3.2

Methodology matrix

Time	Phase	Treatment	Data	Persons Involved
Jan-March 1999	Pre-project	None	-Classroom observations -Videotapes of typical lesson: random and chosen by instructor	-Researcher -Video coders
October-November 1999	-Course reconstruction seminar -Preparation of the Chem 4 course material	None	Course manual for Chem 4	Researcher
November 1999-March 2000	Initial implementation of new Chem 4 course	-Extensive coaching -Frequent meetings or training sessions with the two instructors	-Classroom observation in almost every lesson -Video records -Field notes of meetings -Instructors' journal -Students' interviews	-Researcher -Two instructors -Associate Supervisor -Department Chair
April-May 2000	-Summer implementation of the new course -First revision of the course manual -Training of 13 instructors	-Coaching -Instructors attend lessons -Weekly training sessions -Joint revision and adaptation to the new textbook	-Classroom observation records -Field notes -Revised lesson materials	-Researcher -Associate supervisor -20 instructors
June-October 2000	Departmental implementation in 14 Chem classes	-Coaching -Weekly small group meetings -Monthly large group meetings	-Classroom observations -Video records -Field notes -CUCEI -Checklist -Interviews with teachers and students	-Researcher -Supervisor -Associate supervisor -Content expert colleague -Chairperson -Video coders -702 students

3.3.1.2 Video coding matrix

The data supplied by videotapes were analysed using a video-coding matrix developed by the researcher. The coding matrix consists of statements and questions that looked for evidence of:

- implementation of the plenary-seatwork activity-closure phases of the instructional cycle;
- time logs for each phase;
- maintaining a productive classroom environment such as efficient transition between phases and students listen when someone is reciting;
- keeping students on task;
- providing sufficient guided practice during seatwork activities;
- checking and giving feedback about homework and seatwork assignments;
- monitoring attendance, tardiness and checking textbooks; and
- helping students summarize key points of the lesson.

Other details of the teaching performance such as giving clear and concise directions and information, helping students link new knowledge with previous knowledge, checking frequently for student understanding through questions and providing students with sufficient time to think and respond to questions were also included. A sample of the video-coding matrix is found in Appendix A.

The researcher alone did not do analysis of videotapes. A team of three students were chosen to view all the videotapes and analyse teaching performance using the video coding matrix. The three students, called coders in this study, were in their third year teacher education course with majors in Physics and Chemistry. It is notable that these students belong to the third batch of teacher education students who had undergone rigorous selection and training in science teaching under the STEPS project. Each coder viewed the videotapes and made the coding separately and independently to prevent the influence of one coder with the other coders. In case of misunderstanding, vagueness and problems about coding, coders sought the researcher's help and were not allowed to discuss with one another. The researcher frequently checked the coders to ensure that coding rules were followed. Items in the video coding matrix were checked regularly for similarities and differences of data recorded. Differences of recorded data were probed and clarified through individual coder interviews.

3.3.1.3 Classroom observations

Observations were made in a naturalistic manner, but it was conducted deliberately, systematically and with focus on questions related to the study. A narrative account of the lesson included recording important events concerning the instructors' implementation of plenary-seatwork activity-closure or summary phases, setting up the classroom, managing the class during shifts between phases, interaction with students, student-student interactions, use of textbook, giving and checking homework assignments and monitoring students while on tasks. A sample of the observation form used in this study is in Appendix B. Peer observations included too the aspects described above. Apart from being a source of data, classroom observations were used extensively in coaching.

3.3.1.4 Interviews

Interviews are important tools for the researcher to discover research subjects' feelings and to probe further ideas or statements that are vague (Merriam, 1998). In conducting the interviews, the format suggested by Fontana (2000) was followed. There were no protocols followed and semi-structured interviews were maintained so that there was a casual atmosphere and the interviewees were engaged in real conversations. Semi-structured interviews were conducted with a total of 12 students, with six students in each class, during the pilot implementation of the new course. These interviewees were selected randomly but on the basis of equal numbers of male and female, and the same number of students who attended Chem 4 for the first time and those who attended the same course twice or more (repeater-students). The repeater-students were chosen because the researcher was attempting to determine if the students were able to identify particular characteristics of the new course as compared with the previous Chem 4 course.

During the departmental implementation, interviewees were selected randomly but included three males and two females for each class. It must be noted that engineering classes had more male students than female students. The interviews were conducted two weeks after the schedule of the mid-semester examination and were all tape-recorded and transcribed later. Questions focused on each student's perception of the use of the plenary-seatwork activity-closure or summary phases in teaching Chem 4, the classroom atmosphere, use of textbook, homework assignment and the assistance offered by the instructor. Some of the questions given are shown in Figure 3.3

1. Describe your Chem 4 class before? (this was given to repeaters of the course)
   Describe your Chem 4 class this semester? (this was asked to non repeaters)
2. Do you like the teaching in your Chem 4?
3. Which part you like most?
4. Which part you like least?
5. Could you finish the task/work given to you every session? Why and why not?
6. Do you feel that for every Chem 4 session, you had learned something? Can you give a sample of what you've learned?
7. Do you agree that your learning is made possible because of the teamwork between the teacher and the student?
8. Do you feel responsible of your own learning?
9. If you were to quantify that responsibility, what percentage would you give?
10. What percentage would you give to your teacher in terms of the responsibility of your learning?
11. Give your overall impression of your Chem 4 class.

Figure 3.3
A sample of questions asked of interviewees

3.3.1.5 Journal records

The two instructors who participated in the pilot implementation of the new course were requested to keep their own record of events occurring in their classes. To guide the instructors in writing the journal, the researcher provided a sample journal which was adapted from Kool and Berg (2000) handbook for teaching practice. The instructors' journal included their own interpretation of successful implementation of the new approach, difficulties and problems encountered with the new course, and reactions to the responses and actions of students.

During the departmental implementation of the new course, the same journal guide was given to the 13 instructors. However, the researcher found that most of the instructors were not making a record of their own classroom events and so the researcher changed her strategy. Instead of asking the instructors to keep a journal record, she gave the journal questions as part of the discussions during the monthly meetings with the instructors. Each instructor answered those questions on a paper and the researcher collected them.

The researcher maintained her own journal records. Field-note records included details of pre-and post-observation conferences with each instructor, formal meetings with all the participating instructors, informal sessions with small group of instructors and any general events or observations relevant and interesting to the study.

3.3.1.6 Questionnaires

The quantitative data were derived from the two questionnaires — the College and University Classroom Environment Inventory (CUCEI) developed by Fraser, Treagust, Williamson, and Tobin (1986) and the Students' Perception of the New Chem 4 (SPNC) questionnaire developed by the researcher. Copies of these questionnaires are found in Appendix C and D, respectively. Results of the CUCEI and the perception checklist were compared and analysed for patterns. Triangulation was used as a method to examine the validity of the range of data collected, using various methods described earlier (Cohen & Manion, 1994).

3.4 Data Analysis

According to Lauer and Asher (1988, p. 26), "The most crucial task of a case study, as well as other types of qualitative and quantitative research, is the identification of important variables in the data". Variable identification is either done through coding, setting up and labelling categories or through other forms of content analysis. This process is crucial because the categories and coding schemes established through a search for patterns, as well as deviations from patterns, shape the findings in some ways and contribute to the construction of accepted knowledge (Addison, 1997). Further, in qualitative research "data are recorded as text, and the analysis transforms them into new text"(Nielsen, 1994, p. 4). The researcher's responsibilities with regards to data analysis include seeking patterns of data to develop issues, triangulating important observations and bases for interpretations, seeking alternative interpretations to pursue, and developing assertions about each case (Stake, 2000).

The use of narrative or story to describe events "captures the richness and nuances of meaning in human affairs", while at the same time accommodating "ambiguity and dilemma as central figures or themes"(Carter, 1993, p. 6). In fact, the strength of narrative as a technique for analysis is that it improves communication between people, allows the researcher and subject participants a more engaging type of discourse, thus reducing the gap between abstract research and subjects and enabling more meaningful findings to be extracted (Constas, 1998).

The data collected in this study have been subjected to the process of paradigmatic type of analysis. Paradigmatic analysis of narrative is described as "an examination of data to identify particulars as instances of general notions or concepts and also as a search to locate common themes or create categories" (Polkinghorne, 1995, p. 13). Polkinghorne further identified two groups of categories; those where concepts are derived from previous theory, and those that use inductive analysis, where categories are derived from the data. The inductive analysis approach which is known, as grounded theory was first proposed by Glaser (1967). This method is also called a constant comparative method which proposes that a theory may be generated initially from the data or may be modified or elaborated if existing grounded theories seem appropriate to the area of investigation (Strauss & Corbin, 1994, p. 273). Grounded theory is a general methodology for developing theory that is grounded in data systematically gathered and analysed (Ryan & Bernard, 2000; Strauss & Corbin, 1994), and is a method of "building a theory based on descriptive data grounded in real life situation" (Merriam, 1998, p. 26).

Guided by the theoretical framework described above, the analysis of data in this study began when the researcher was observing classes. After each observation, field-notes were consolidated and some elements of the instructor's actions were identified. Small patterns of teaching related to the use of plenary-seatwork activity-closure or summary phases, monitoring students' seatwork and homework assignments, and classroom organization were noted and used as bases for coaching and the next observations. This pattern of analysis was followed on an increasing scale until the researcher had accumulated sufficient of examples of classroom practices. Video-records of classes were transcribed and analysed for teaching patterns, identifying similarities and differences of actions related to the adoption of the new teaching model. Videotapes also were used to cross-check teaching and learning actions and compared with the data collected from observations until categories of instructors' emerged.

Results of the two questionnaires were analysed, compared and patterns were also identified. Basic statistical tools such as the mean, alpha reliability, analysis of variance (ANOVA) were determined using the SPSS software. The students' interview transcripts were used as a cross-reference to the instructors' journal records and statements during small group discussions and to complement the quantitative data that were obtained through the questionnaires. The qualitative and quantitative data were melded and examined, and links were clarified and established to support or refute the research questions set in Chapter 1. In some cases, the data revealed surprising aspects of the study; however, possible explanations of these aspects were also reported.

3.4.1 Names used for data

The large amount of data collected that were derived from various sources was presented using a certain mechanism. Instructors were given names such as A, B, C, D, until Q. Students' names are assigned with numbers 1, 2, 3, and so on. Likewise the date of data collection is also indicated. For example a direct quote from a student during an interview appears in the text as 'Interview with Student # 10; 23/02/00'. A quote from a student derived from the questionnaire is shown in the text as 'Student # 2 of Instructor F; 10/00'. Instructors' direct quotes during group sessions are presented in the text as 'Instructor I; 30/06/00'. Quotes obtained from the researcher's journal record are labelled as 'Observation; 30/06/00' or 'Small group session, 11/07/00'.

3.5 Summary

The purpose of the study was to start a process of course and faculty development that aimed at increasing the mental effort of students in and outside of the classroom. A chemistry course was revised to apply a instructional cycle approach in which each class meeting consisted of one or more cycles of three phases: (a) plenary or mini-lecture, (b) seatwork activity, and (c) closure or summary. The approach was designed to improve basic teaching skills and to enhance instructors' knowledge of student learning difficulties.

To address these aims, a qualitative interpretive case study was adopted because the research method emphasizes exploration, explanation, description and evaluation of subject participants' actions. A range of data collection procedures was employed, including classroom observations, video-records of classes, semi-structured interviews, journal keeping and use of questionnaires. The multiple sources of data enabled the collection of rich descriptions of instructors' classroom practices while they were adopting the instructional cycle model in the teaching Chem 4 course. Instructors' progress also was monitored by cross checking a range of data. The paradigmatic analysis of narrative and the use of case study provided explanations, themes, and patterns and identified issues of concern related to the research.

CHAPTER 4
TEACHING AND LEARNING BEFORE THE PROJECT

4.0 Overview

The Science and Mathematics Education Institute (SMEI) through the Dutch funded Science Teacher Education Project-Southern Philippines (STEPS) was established at the University of San Carlos in early 1996. Its task was to improve the pre-service and in-service programs of science and mathematics education in the university and in the community. Good science/mathematics teacher education requires quality teaching in the science/mathematics departments. Therefore STEPS embarked on a process of improvement of teaching and learning in the large enrolment science and mathematics service courses. This thesis describes a pilot project that was conducted in 1999 and 2000. As of mid 2002 over 15 science/mathematics courses have been modified involving over 6000 students per year.

Before any reconstruction of courses could be done, it was necessary to know the current status of the curriculum and the teaching and learning in particular in the university. Thus a pre-project inquiry was undertaken as the first stage of the research project. This chapter reports on the status of the teaching and learning of the General Chemistry course offered by the Chemistry Department at USC before any reform was undertaken. The department was the priority choice because it is a large department that handles all the chemistry courses for both undergraduate and graduate levels either as service or major courses. The Department is considered to be one of the better performing departments in the University and STEPS has a standing impression that its faculty and staff are supportive of innovations introduced. Likewise, the researcher belongs to this Department, too.

4.1 The Teaching of Introductory Chemistry

In order to describe typical chemistry teaching in the department prior to the commencement of the project, 18 General Chemistry class sessions were videotaped. Nine instructors who taught these classes were videotaped twice; one session was unannounced and the other was announced or scheduled in consultation with the instructor. The unannounced videotapes were intended to show the typical teaching and learning in a General Chemistry class while the announced videotapes were intended to measure the instructors' maximum performance and perception of best practice.

Table 4.1

Time in minutes and percentage of time spent for actual teaching in unannounced and announced lessons

Instructor	Time in minutes				% time	
	Unannounced video		Announced video		Unannounced video	Announced video
	Official	Actual	Official	Actual		
A	90	56.6	90	46.7	62.9	51.8
B	60	40.5	60	41.2	67.5	68.7
C	60	45.1	60	48.2	75.2	80.3
D	90	55.0	60	44.3	61.1	73.8
E	90	48.1	90	43.9	53.4	48.8
F	60	47.3	60	55.8	78.8	93.0
N	90	59.4	*120	92.5	66.0	77.1
O	60	42.0	60	45.9	70.0	76.5
P	90	29.9	60	33.6	33.2	56.0

* an integrated lecture and laboratory course

The scheduled allocated time for each General Chemistry session and the actual time spent for actual teaching of Chemistry by each instructor for both unannounced and announced videotapes of teaching are presented in Table 4.1 The actual time is defined as the time from when the instructor starts the class until the end of the session. Time for any prayers, announcements, returning test papers or giving homework is counted. As can be seen in Table 4.1, the percentage of time differed quite considerably between instructors in their use of actual class time. Although there was general increase of time spent by the instructor in the classroom when the videotaping was announced compared it to being unannounced, unused time when the instructor was not in the classroom took a considerable amount of the class time; time lost from teaching ranged from 7.0% to 66.8% of the class-scheduled time. Observations by the researcher showed that the loss of time was largely due to the instructor waiting for students prior to beginning the lesson and in a few cases, instructors coming late.

Table 4.2

Time in minutes spent for each phase and percentage of time for unannounced lesson

Instructor	Actual time	Plenary	%	Seat work	%	Closure/ Summary	%	Other	%
A	56.6	56.3	99.5	-	-	-	-	0.3	0.5
B	40.5	40.4	99.8	-	-	-	-	0.1	0.2
C	45.1	45.1	100.0	-	-	-	-	-	-
D	55.0	54.5	99.5	-	-	-	-	0.5	0.5
E	48.1	48.1	100.0	-	-	-	-	-	-
F	47.3	47.3	100.0	-	-	-	-	-	-
N	59.4	46.6	78.5	6.9	11.6	5.0	8.4	0.9	1.5
O	42.0	41.9	99.8	-	-	-	-	0.1	0.2
P	29.9	29.1	97.3	-	-	-	-	0.8	2.7

A summary of the teaching phases for each instructor when the videotaping was unannounced is shown in Table 4.2. The teaching phases are plenary, seatwork/activity and closure or summary. A plenary is either a whole-class part of the lesson where all students listen to the teacher or a fellow student, a lecture, or a whole class discussion. A seatwork/activity is a learning task for students, either guided or independent practice by students on problems, questions or activities. In this phase, the instructor moves around the classroom to monitor students' learning and identify any difficulties or common mistakes and react to them. The closure or summary phase is where the instructor gives feedback about students' work and discusses any corrections about the seatwork or activity.

A plenary was the dominant phase of teaching General Chemistry course. Indeed instructors C, E, and F had used all class time for lecturing. Instructors A, B, D, O, and P had used almost all the class time for plenary with very little time for seatwork activities. Other class activities included prayers, announcements and returning test papers. Only instructor N had implemented the three phases of teaching that comprises plenary, seatwork, and closure even though a large amount of time (78.5 %) was still focused on the plenary.

Table 4.3

Time in minutes spent for each phase and percentage of time for announced lessons

Teacher	Actual time	Plenary	%	Seat-work	%	Closure/ Summary	%	Other	%
A	46.7	45.7	97.9	-	-	-	-	1.0	2.1
B	41.2	40.3	97.8	-	-	-	-	0.9	2.2
C	48.2	35.7	74.1	6.1 (quiz)	12.7	5.9	12.2	0.5	1.0
D	44.3	44.0	99.3	-	-	-	-	0.3	0.7
E	43.9	43.9	100.0	-	-	-	-	-	-
F	55.8	37.4	67.0	8.8	15.8	7.7	13.8	1.9	3.4
N	*92.5	33.3	36.0	33.0	35.6	24.2	26.2	2.0	2.2
O	45.9	45.4	98.9	-	-	-	-	0.5	1.1
P	33.6	32.7	97.3	-	-	-	-	0.9	2.7

* an integrated lecture-laboratory course

Six instructors (A, B, D, E, O, and I) spent almost all the lesson and instructors C and F spent 74.1% and 67.0%, respectively, of the class time for plenary lecturing even though they were on their maximum performance. However, instructors C, F and N implemented the three phases of teaching in their class. Instructor C gave a problem on the calculation of a chemical equilibrium constant as a quiz instead of non-graded seatwork, but the time allotted for students' independent work was only 12.7% of the lesson time. Instructors F and N provided non-graded work for the students by giving them a standard problem involving equilibrium constant calculations. Instructors C and F provided inadequate time, only 12.7% and 15.8% of the actual time, for students work and almost negligible time for giving feedback about the problem being solved during the seatwork phase. This could mean that even though the instructors were executing their perception of best practice (the videotaping session had been scheduled in consultation with them), the lecture method remained the favoured mode of teaching. Instructor N, on the other hand, who consistently implemented the three phases of teaching in her class, is considered to be one of the better teachers in the Chemistry Department.

As shown in Tables 4.2 and 4.3, most time was spent on plenary teaching methods. A plenary lesson could still actively involve students, but in most of the lessons observed, the teaching scenario was for the instructor to be speaking and writing at the front while the students were passive. The time for seatwork was insufficient for the students to be actively involved in the class. Each of the instructors provided negligible time for giving feedback on the student's work or making some form of a closure or summary of the lesson. This meant that students rarely had any opportunity to identify their own learning difficulties and be able to ask questions and obtain feedback from the instructor.

4.2 Overview of Teaching Practices

Teaching practices analysed from 18 videotapes of nine instructors showed that the instruction in these classrooms was traditional and the students were rather passive. The lesson time was filled by talk of the instructor consisting of the plenary phase. The plenary session, in order of decreasing time allocation, included lesson review, lecture on new topic, lecture combined with questioning and writing notes on the board, lecture combined with writing notes on the board, lecture combined with questioning, instructions on what students should do during seatwork, explaining a small part of an activity, discussion on items in the previously given test, and discussion about the questions given in the homework.

A lesson review usually consisted of recall of the previous day's lesson and was often initiated by the instructor either to start a lesson or to introduce a new lesson. Lecturing then proceeded which was normally combined with questioning and writing notes on the board. As shown in Table 4.4, the number of questions asked varied between instructors. The number of questions is the average of the number of questions tallied by the three independent observers. For unannounced videos, Instructor F had the highest number of questions asked (74) within a 47-minute plenary session while Instructor P had the least number of questions asked (9) within a 30-minute plenary phase. It was noted during the observations that Instructor F used questioning to ensure students were paying attention to what she was saying and to maintain control of the classroom situation. On the other hand, Instructor P's teaching mode was characterized by an information transfer where learning was centred around what information could be delivered.

Table 4.4

Number of questions per instructor and the mode of students' answers in unannounced lessons

Instructor	Average number of questions asked	Average number of questions answered			Average number of unanswered questions
		in chorus	individually	instructor	
A	41	22	8	11	1
B	39	9	18	5	7
C	68	21	30	4	13
D	17	5	2	7	3
E	41	19	8	5	9
F	74	25	9	30	10
N	68	31	15	6	16
O	32	23	0	2	7
P	9	6	0	1	2

The question profile for lessons with announced videotaping is presented in Table 4.5. The highest number of questions asked was 68, the second highest was 52 and the least was 9. Instructor O asked 68 questions within a 35 to 37-minute plenary session of which students answered only one individually, 40 were responded in chorus, 3 questions remained unanswered and the instructor herself answered 24 questions. Instructor E, on the other hand, asked 52 questions of which 36 questions were answered by students in chorus, no questions were unanswered, eight questions were answered individually and the instructor herself answered eight questions. Both instructors were trying to make their instruction interactive by asking many questions but the choral mode of answering the questions indicates that the questions did not solicit explanation or engage the students into deep thinking. This was true with other instructors because most of the questions posed also were responded chorally. It should be pointed out that questions with choral answers usually are only memory questions. Questions that aim at engendering chains of argument and reasoning going in the classroom cannot be choral.

In Tables 4.4 and 4.5, Instructor P had the same number of questions asked during plenary times, for both presumed routine and maximum performance. This instructor had the least number of questions asked, the majority of which were answered in chorus. As indicated earlier, Instructor P was concerned about delivering the content information to the students through the lecture mode. It was also noted that most of the instructors did not emphasize order in the classroom and that most students talked and were noisy while the instructor was lecturing.

Table 4.5

Number of questions per instructor and the mode of students' answers in announced lessons

Instructor	Total questions asked	Number of questions answered			Number of unanswered questions
		in chorus	individually	instructor	
A	39	26	10	3	0
B	43	20	17	6	0
C	42	24	9	9	0
D	27	14	5	8	0
E	52	36	8	8	0
F	12	6	3	2	0
N	34	12	16	3	3
O	68	40	1	24	3
P	9	8	0	0	1

The choral answers to instructors' questions indicate that these questions were low level, emphasizing memorization of facts, stating definitions and laws. Even questions that were answered by students individually or by the instructor herself were of low level and were only checking students' memorization of terms rather than stimulating ideas. There were more unanswered questions in classes where videos were unannounced than when videos were announced which could be attributed to the preparation of the instructor for the class (see Lesson 1 in Figure 4.1). A well prepared instructor would plan for the chronology of the lesson together with the questions and their answers while an instructor who was notified of the video a few minutes before the class started would possibly tended to ask a lot of questions without being aware whether those questions could be answered or not.

4.2.1 Lesson 1: Lengthy review and low-level questions

Lesson 1 in Figure 4.1 was a transcript of an excerpt from an unannounced video lesson in General Chemistry. It was one of the lessons that caught the researcher's attention because it illustrated two classroom issues, lengthy review and low-level questions.

Lesson 1

(In this lesson transcription, the following codes were used; C stands for instructor and S, for student/s).

This was a mid-morning one-hour class taught to freshmen engineering students. The instructor has more than 20 years of teaching the course to similar groups of students. The class started 15 minutes late because more students were coming into the class. As a routine procedure, the session started with a prayer and a good morning greeting to the teacher. Then the instructor started asking questions.

C: What are the two sub-topics that we were talking about… that is… in chemical kinetics? What are we talking about?
S: (in chorus) The rate of reaction.
C: and … S: (in chorus) the reaction mechanism.
C: (Repeats students' answer and writes them on the board.) What do we mean when we say rate of reaction? What do you understand now from the discussion that we had? What do you mean by rate of reaction? (long pause….)
S: (in chorus) change of concentration
C: change of concentration… of what? reactants?…only?… It could be a rate of the concentration…change of concentration of the product…. always per unit time..okay.. and so when we talk about reaction, to what are we referring? When could a reaction occur? When did we say? What evidence in your…….observation….as per your experience, how would you know that there is a reaction that already occurred?
S: (in chorus) There is a new product formed.
C: There is a new product formed. How do you know that there is a new product formed?
S: (in chorus) change… C: in….. S: colour
C: What would be an evidence, concrete evidence that there has been a reaction? How would you know that there is a reaction taking place? Yes… pointing to a student.
S: The properties exhibited will now be different.
C: (repeats)… the properties exhibited will now be different….how would you know that? (long silence)
C: The properties of the substances now will be different from the….. S: (in chorus) previous.
C: How would you know that you observed these properties? How would you know? What is…some evidences that there has been a reaction taking place, concrete…what would be… how would you know… for instance that aluminium has already reacted with HCl?….this a common and a familiar….. alright (pointing to a student)… S: bubbles
C: bubbling will be observed; bubbles will be formed, in other words, what are those bubbles?
S: (in chorus) gas
C: This is therefore one evidence, what else?
S: (in chorus) formation of a precipitate C: alright… formation of a precipitate

C: We further discuss that there will be some factors that affect the rate of the reaction, how many factors that we were able to discuss?
S: (in chorus) four
C: Which are these?
S: (in chorus and very noisy) temperature, concentration, surface area catalyst
C: May I ask somebody please (pointing to a student)
S: Temperature, concentration of reactants, catalyst, surface area
C: (stating these four factors again while writing them on the board.) Of course there was one that we obviously know that can affect the rate but which is not controllable. What am I talking about? One factor that can definitely cause a rate... rate of reaction but this cannot be controlled, the nature of the....
S: (in chorus) reactants
C: These things can be controlled (making a bracket on the 4 factors written on the board) that is, why.. these are ones that we are trying to study. So that we will find meaning and application of these when we would want our rates of reaction either faster or slower. We have already discussed how these different factors affect the rate of reaction and why?... Yes.. Are there any questions so far?
S: No Maam.
C: No! Is this understood?
S: (in chorus) Yes.
C: Then we were talking of an expression that relates the rate of reaction to the concentration of the reactant and what are we referring to?
S: (in chorus) the rate law C: (repeat)... the rate law
C: What is then rate law? (stated twice). What do you understand of a rate law? (calling a student)
S: (trying to read her notes)... Rate law is....
C: Don't look at your notes. I wanted you to say it in your own words so that I would know how far this has been understood by you.
S: (continue stating the definition of rate law with some words coming from the teacher). Rate law...relates the rate of a chemical reaction....
C: to the concentration of the... S: reactants

Then the teacher continued to discuss rate law, give two examples on how to write a rate law expression.... And then say...

T: These things had already been discussed, I understood, I'm just trying to find out if you understand what we had discussed in the past. Is this clear?.. Then we go to the order of the reaction...(She gave a lecture on order of the reaction and activation energy.. and then later ended the session by announcing a short quiz).

Figure 4.1

Transcript of lesson 1 from unannounced video of Instructor C illustrating low level questions and a lengthy lesson review

An examination of the lesson 1 shows that the teaching is traditional. The students were seated facing the instructor and the chalkboard while taking notes and listening to the instructor's talk. The instructor worked with the whole class and was in control of the overall transactions in class. The teaching style demonstrated a lecture that manages not to be completely monologue but it shows more or less degrees of interactivity because of the many questions asked by the instructor. Interaction was limited to teacher-student discourse. There was no evidence of student initiated or maintained interaction despite the instructor using actual data obtained from their laboratory experiment to highlight the topic on rates of reaction. The instructor had difficulty eliciting responses from the students and so the questions had to be repeated more than twice or the instructor had to point to somebody to answer the question. It was also observed that most students were inattentive.

Furthermore, the instructor (C) asked 19 questions where 13 of those questions were responded to in chorus and only six were answered individually. The majority of the questions asked were found to be low level. Low level type of questions demand statement of facts and definitions of terms which could be answered with one or two words. While the instructor was trying to generate interactions from students through asking many questions, she might be avoiding moving forward to deal with the next lesson by extending the review session. This intention was revealed when Instructor C told the students that she was trying to find out if they had understood the past lesson. Reviewing past lessons can lead to student interactivity, resulting in ineffective time management, depriving students of the new subject matter to be learned. This teaching approach might be one of the causes of not being able to finish the mandated subject matter content in the course syllabi, which many college instructors blame on the poor preparation of the students.

In this case, the instructor provided very little new material in this lesson but rather focused on the previously acquired knowledge that the students should have learned before a new lesson is learned. There is nothing wrong with lesson review using the question and answer method as long as the emphasis of such method is more on the exploration of answers to the questions rather than just answering in one word or short phrases. The instructor neglected to link the macroscopic variables to a microscopic view of reactions. Without a microscopic view students just have to memorize the factors influencing the rates of reaction while with the microscopic view they can understand these factors.

4.2.2 Lesson 2: Routine calculations rather than concepts

Solving standard problems was also a popular teaching activity during the plenary phase. The instructor wrote the problem on the board, as the majority of the students did not bring textbooks with them to class; likewise, the instructors never checked if students had these textbooks. A stepwise procedure in solving standard problems was followed by the instructor who sometimes was in danger of misleading the students. Lesson 2 shows an example of a plenary lecture where Instructor D presented a standard problem on chemical equilibrium. In this lesson, two types of solutions are shown; the solution presented by the teacher on the chalkboard, and the solution found in the textbook (Mortimer, 1986, pp. 417-418).

Lesson 2

This is a transcript from an unannounced video lesson in General Chemistry taught to engineering students. The class is 1.5 hours and the instructor had been teaching this course for five years.

The lesson proper started with the instructor stating: "We started last time our lesson on chemical equilibrium. An example of homogeneous equilibrium.." then she wrote this problem on the board...

At 500 K, 1.00 mol of $ONCl_{(g)}$ is introduced into a one-litre container. At equilibrium, the $ONCl_{(g)}$ is 9.0 % dissociated:

$$2ONCl_{(g)} \rightleftharpoons 2NO_{(g)} + Cl_{2(g)}$$

Calculate the value of K_c for the equilibrium at 500 K.

D: That problem is an example of a homogeneous equilibrium wherein all the reactants and products are gases. She reads the problem written on the board. At the start, what is the concentration of your.... remember class, you want to solve the value of K_c, you want to know the concentration of the product and the concentration of the reactants at equilibrium, okay? So at the start, what is the concentration of your reactants? At the start you have.....
S: quotient
D: No, I want the value; a number.
S: one mole
D: Okay, how about your products now, at the start....

S: zero

D: During the reaction, class, what is now the concentration of your reactants? At the start of 1 mole, during the reaction, what is now the concentration of your..... ahhh... reactant, ONCl? Look at the problem now, at equilibrium we have 9% dissociated, so we have 1 times 0.09 so we have now .09 mole. How about.... What is now the concentration of your NO? From the equation 2 ONCl produces 2 moles NO and 1 mole Chlorine gas. What is the concentration of your NO? 2 is to 1 so if you have 0.90 mole you have also 0.90 moleNO. How about your chlorine gas? The ratio is 2:2:1 so it is 0.045. During equilibrium, class, what is now the concentration of your reactant? You have 1- 0.09, you have 0.91. How about this one (pointing to NO and Cl_2). It is 0.09 for NO and 0.045 for Cl_2. Below is the summary written on the board.

	$2\ ONCl_{(g)}$	$\rightleftharpoons$	$2\ NO_{(g)}$	+	$Cl_{2(g)}$
at start:	1.00 mole		0		0
reaction:	1.00(0.09)= 0.09		0.09		0.045
at equil:	1.00-0.09= 0.91		0.09		0.045

D: (continues) So you substitute now. What is the answer in your calculator?

S: (in chorus) 4.4×10^{-4}

D: Is that correct? What is the unit now?

S: (in chorus) moles per litre

D: Remember the concentration is expressed in molarity or mol/L. So you know now how to determine the value of K_c ?

Figure 4.2

Transcript of lesson 2 of unannounced video of Instructor D showing missed opportunity to solve standard problems

The students were observed to be inattentive at this point and the observer could not hear what the instructor was saying and so she got a textbook and looked at the topic being discussed. She found out in the book the problem being discussed together with the solution. The solution of the problem as presented in the textbook (Mortimer, 1986, pp. 417-418) is shown in Figure 4.3.

By considering exactly one liter, we simplify the problem, since the number of moles of gas is the same as the concentration of the gas (in mol/L). Since the ONCl is 9.0 % dissociated, number of moles dissociated = 0.090(1.00 mol) = 0.090 mol ONCl

We must subtract this quantity from the number of moles of ONCl present initially. The concentration of ONCl at equilibrium, therefore is [ONCl] = 1.00 mol/L - 0.090 mol/L = 0.91 mol/L

The ONCl that dissociates produces NO and Cl_2. We can derive the amounts of these substances produced from the coefficients of the chemical equation:

$$2\ ONCl \rightleftharpoons 2\ NO + Cl_2$$

0.090 mol   0.045 mol

Since 2 moles of ONCl produce 2 mol of NO, 0.090 mol of ONCl will produce 0.090 mol of NO. The equation shows that 2 mol of ONCl produces only 1 mol of Cl_2; therefore, 0.090 mole ONCl will produce 0.045 mol of Cl_2. The equilibrium concentrations are: [ONCl] = 0.91 mol/L; [NO] = 0.090 mol/L; $[Cl_2]$ = 0.045 mol/L

A technique for developing data of this type consists of the preparation of a table showing the initial concentrations, the changes in these values, and finally the equilibrium concentrations. The stoichiometry of the reaction enters into the derivation of values for the second row (*under change*).

	2 ONCl	$\rightleftharpoons$ 2 NO	+ Cl_2
at start:	1.00 mol/L	-	-
change:	-0.090 mol/L	+ 0.090 mol/L	+ 0.045 mol/L
at equilibrium:	0.91 mol/L	0.090 mol/L	0.045 mol/L

Therefore, substituting in the equation

$$K = \frac{[NO]^2\ [Cl]}{[ONCl]^2}$$

$$K = 4.4 \times 10^{-4}\ mol/L$$

Figure 4.3

The solution to the equilibrium problem from Lesson 2 as presented in the textbook.

Lesson 2 shows a missed opportunity to have students be active by letting them solve the problem individually as seatwork and to introduce the Mortimer problem which is a nice template for this kind of problem.

The short introduction given by the instructor was just a restatement of facts and figures given in the problem. The instructor asked only simple and low level questions. Even with a low demand question, students had difficulty in giving correct answers. Either the students were unprepared for the lesson, were indifferent or just did not understand the concept on chemical equilibrium. The error on the second row in the instructor's solution written on the board was never noticed until the end of the session. The instructor wrote "reaction" instead of "change" and then multiplied one by 0.09 without giving the meaning of 0.09 being the number of moles of ONCl that had dissociated. Students' previous knowledge on stoichiometry could have been used to link concepts. The students, on the other hand, were not able to look at their textbook on the solution presented by their instructor, as nobody had a textbook in the class. Instead they just copied notes from the chalkboard.

The error was pointed out to the instructor after the class and, surprisingly, the instructor was not aware of the error. This is an indication that the teaching was focused on taking the students' through the routine calculations rather than developing students understanding of the procedure for calculating the equilibrium constants and in turn finding out the meaning of such data. The choice of words used by the instructor may create confusion and the problems or concept become vague. The continuous repetition of questions and statements done by the instructor could increase the monotony and bored the students. It would be better to let the students do the problem. The instructor could go around and find out where students have difficulties with the lesson.

4.2.3 Board-work

The most common alternative to the lecture method was board-work which is often employed in chemistry lessons that are largely quantitative such as stoichiometry, gas laws, thermochemistry and chemical equilibrium. In nine of the 18 videotaped lessons, the strategy used by the instructor was to write one to two algorithmic problems on the chalkboard and announce to the class that everybody should work on the calculations on their notes. Just after the announcements was given, the instructor called one or two students to work through calculations on the chalkboard even though other students have not yet started on their own calculations. Usually the most active and competent students were selected to do the board-work and so the students working on the board were likely to be more competent than the other students in the classroom. The result is that the other students do not try to solve the problem anymore, they just copy from the chalkboard.

In any case, board-work was used such that only two or three students were mentally active while most students were still mentally passive. Students who were inactive indulged in conversation with other students and did not copy notes from the chalkboard. Oftentimes the conversation in the classroom was between the board worker and the instructor, neglecting other students. This situation, which created a noisy classroom atmosphere where learning seems impossible, happened usually in engineering classes; however, this problem is not officially recognized as a factor contributing to students' low performance. Frequently, college instructors in the Philippines believe that keeping discipline to create a good learning atmosphere is the responsibility of students rather than of the instructors.

4.2.4 Homework

Homework was also a common strategy employed by the instructors. In eight of 18 videotaped classes, the instructors had given homework in the previous lesson; however, only one instructor had a quick visual check of whether or not students had done their homework. The homework was generally in the form of reading topics from certain pages in the chapter for the next session and solving algorithmic problems at the end of the chapter in the textbook. Homework was usually given at the later part of the class period, usually in the few remaining minutes of the lesson, dictated to the class and was often general and broad. Only one instructor had assigned homework with guide questions to help students relate and compare the data collected during the day's group activity and the given theoretical data. In the next session, this instructor used the above homework to start the discussion in class, but like all the other instructors, she did not conduct either random or visual checking of homework of the students.

Informal interviews with the instructors revealed that homework was given to motivate and /or put pressure on students to read and study the previous lesson and for discussion in the next session. The instructors also estimated that in a class of 55 students, a maximum of five students religiously do their own homework and the rest just copied from classmates or friends while others did not do anything at all. This was the reason why instructors do not check nor monitor homework, as they find checking time consuming and frustrating because often solutions to problems are exactly the same. However, if the homework is accompanied by a quiz, then the students will study.

The assertion of the instructors about the inability of the students to do homework was consistent, with the students accepting the fact that they do not like homework, too. Interviews with students indicated that having no textbook, being given too many problem sets, too many pages to read and the inability of the instructor to check the homework were the main reasons why homework was not done. The students also indicated that if a quiz is announced about the homework, then they would do their homework. This means then that students will generally study their lesson to pass a test and not because they want to learn from the course.

4.2.5 Classroom management

Although the instructors were in control of the class, the classroom atmosphere was sometimes unconducive to learning. A substantial number of students came late to class and they not only disrupted the attention of other students but also required the instructors to delay the class or often repeat the initial part of the lesson. This practice contributed to the low percentage of actual time employed by most instructors in class (see Tables 4.1 and 4.2). Most instructors rarely monitored students' attendance and tardiness, likewise they often ignored students coming very late in class.

In many cases, students indulged in conversation with other students while the instructor was talking and even during discussion. As observed, the majority of the instructors rarely manifested the following behaviours in class:

- gave encouragement or motivated students to listen and participate in class,
- listened actively,
- controlled and maintained student discipline throughout the session,
- addressed the right undisciplined students, and
- paid attention to a good working environment.

No instructor had shown an indication on how students should improve their behaviour while only one instructor was giving recognition to the desired answer and good behaviour of students.

In all the classes observed, the majority of the students came to class without textbooks. Indeed, the textbook was rarely used in class as the instructor simply gave lectures and wrote definitions, formula and other notes on the chalkboard. Based on comments from both the instructors and the students a textbook for the General Chemistry course was required although students had an option whether to have or not to have a textbook. The required textbook could be bought from a local bookstore or loaned from the university's textbook department.

4.3 Summary

To summarize this chapter, the researcher focused on the frequently observed situations in General Chemistry classrooms at the University of San Carlos, Cebu city, the Philippines.

- The actual time spent for classes ranges from 33.2-91.4 % of the official time provided by the university. A lot of time was wasted due to tardiness of students that the instructors do not try to control.
- The majority of the General Chemistry instructors used almost all the lesson time for plenary lecturing where the students are passive.

- The focus in teaching was often on doing standard problems and not on concepts, conceptual difficulties, and the role of context in applying chemistry concepts. There was often blind use of formula work without the conceptual understanding that is needed to realize whether outcomes of problems are sensible.
- An alternative to the lecture method is board work which was often applied such that most students are still mentally passive.
- Students have no books and mainly study from notes taken in class. Students' notes are often inadequate because instructors never checked them.
- There was no systematic and sustained effort of instructors to stimulate and maintain student work in the course. The instructor may give homework assignments but never checked or used the assignment in class, thus undermining student dedication.
- Oftentimes the classroom atmosphere was so noisy that learning seemed impossible, especially in engineering classes, but this problem was not officially recognized as a factor contributing to low performance.
- Though the instructors in this department are all Chemistry majors, this is not a guarantee for subject matter mastery at the BS level. Likewise, the instructors long experience in teaching did not provide them with adequate pedagogical skills to meet the needs of the learners.

CHAPTER 5
THE INITIAL STUDY FOR RECONCEPTUALIZATION OF CHEM 4

5.0 Overview

The data in Chapter 4 indicated that the presently unsuccessful instructional mode for chemistry classes in the Chemistry Department at the University of San Carlos is the traditional lecture. This style of teaching, which is referred to as data dumping or spraying (Cummings, 2000), expects students to listen and encourages them to be passive. To meet all the needs of learners, the traditional mode of delivery must be modified. Instead, instructors must build up a wide repertoire of teaching skills for effective and competent teaching. Likewise, course materials must be aligned to fit into a teaching and learning framework that encourages and describes the second stage of the research project student active participation.

This chapter consists of five sections and describes the second stage of the research project. The first section features the new course structure for Chem 4 which includes the sequence of topics in the course matrix, the teaching scheme used in the new course and the description of the subjects involved in the initial stage of the study. The second section describes the process on how the new course was taught with subsections on the instructor learning and improving instructional skills through coaching. The third section narrates the effective implementation of classroom routines such as tardiness and attendance, textbooks, homework and order in the classroom. The fourth section reports on the instructor's adapting the instructional cycle model which consists of plenary, seatwork activity and closure or summary phases. The last section discusses the implications of the pilot study for departmental implementation.

5.1 The New Course Structure for Chem 4

Between October and November 1999, a two-week long seminar-workshop on course development was conducted by a Dutch visiting consultant in the University's Science and Mathematics Education Institute (SMEI). The seminar workshop started with a three-day orientation on teaching and learning. After that the ten participants developed course manuals individually while consulting once a day individually for 30 to 60 minutes with the consultant. The workshop highlighted three basic phases in the teaching and learning process (Rooijakers, 1999): orientation, exercise and feedback. Orientation includes theory, the way to think about and use the content. Exercise is for student seatwork and is dependent on the information given during the orientation phase. The feedback portion is making the students aware of their learning or steering student thinking (Rooijakers, 1999). As a whole, the workshop was centred on identifying an appropriate system or approach in teaching and learning in order to maximize student intellectual engagement both in and outside class time.

The researcher, together with two colleagues involved in this study, attended the seminar. The researcher prepared the course manual for Chem 4 while the two colleagues prepared manuals for two other chemistry courses. These course manuals were intended for use by instructors in the Chemistry Department. However, only Chem 4 was implemented immediately. Another five participants worked on mathematics courses and on a science education course.

There are nine chapters in the course manual for teachers. Chapter I is a brief purpose of the course. Chapter II describes the general scope of the course. Chapter III gives the main subjects and sub- subject contents divided into eight lesson units. Chapter IV indicates connections between main subjects and within subjects, while Chapter V shows the instructional goals for each lesson unit stated as either teaching or learning goals. An estimate of the time allocated for each lesson unit is summarized in Chapter VI.

Chapter VII is the course matrix, which is a detailed guide for the instructor to implement in the classroom, and has three sections. The matrix is the core of the course manual as it shows the instructional cycle for each lesson. The first column consists of the learning targets, which refer to the specific objectives of the lesson. The second column covers the activities and lists the tasks of both teacher and students to achieve the learning objectives. The third column is estimated time allocated for achieving each learning target. Overall, the course matrix emphasis is on the focus of the sub-topic, what students should be exposed to and learn in the course.

Chapter VIII is a list of sources for instructor and student readings and Chapter IX shows an inventory of the learning targets, classified as knowledge, understanding and application. Though all eight chapters are equally important because they serve as a guide for teaching Chem 4, Chapter VII, the course matrix, is given special attention in this study. Figure 5.1 is an example of a lesson included in Chapter VII.

Learning Target	Activities	Time Allocation
Describe matter by its properties.	T1: Prepare 10 trays containing different materials (at least 10) a day before the class. Introduce the topic by asking students how they recognize their friends. From the students' responses enumerate some properties of matter. Group students into 10 (4-5 members per group) and give instruction. S: Take note of the characteristics of the given materials. Discuss within the group, the characteristics like form/state, volume, mass, etc. T: Go around and check the work of each group. Lead them into achieving the learning target. S: Describe matter by stating the different Properties of that material. Report in class. T2: React to student's responses. Give additional demonstration or activity showing volume and mass characteristics if students are not able to define these. Students should reach a definition of matter as something that occupies space and has mass.	30 Minutes
Distinguish between chemical and physical properties; intensive and extensive properties.	T: Give a short plenary on the properties of matter; physical and chemical; extensive and intensive. Introduce the next activity. S: Examine the list of properties your group had made. Distinguish which is physical and chemical; intensive and extensive. Support with reason the distinction you have made. T: Check the work of the students and make comments. Proceed to the next activity. Give more examples to illustrate chemical property.	15 Minutes
Predict the use of a material based on the given set of properties of that material.	T: State that knowledge of the properties of materials determines their uses. From the list of materials in your group predict the use of these materials based on their properties. Tabulate your data as: Material Properties Uses S: Write them on manila paper and report in class T: React on report and point out that this is one practical application of knowing properties of matter.	15 Minutes

Figure 5.1
A sample lesson in the course matrix

5.1.1 Sequence of topic units in the course matrix

The design of a set of lessons for the entire semester in Chem 4 had no change in the traditional content of the current Chem 4 course, but there were significant differences in the sequence in which the content was presented and in the teaching methodology recommended. The sequence of topics and their relationships for the new Chem 4 course are shown in Figure 5.2.

Figure 5.2 also shows the connection between topics. The sequence of topic units suggested for the new Chem 4 begins with the importance of chemistry and the different forms of matter. Although these topics are emphasized at the high school level, local studies have shown limited student understanding of chemistry concepts due to lack of course content background (Berg et al., 1998; Magno, 1996; Somerset et al., 1999). Thus the topics are included in the college introductory chemistry courses. The next two topics deal with the macroscopic and microscopic nature and structure of matter, a theme that provides a logical introduction to the next topic on chemical bonding.

The first four topics provide a basic set of concepts and principles in chemistry to allow instructors to either take up the topic on gases, intermolecular forces, liquids and solids or the topic on chemical reactions and stoichiometry. The last topic on energetics deals with basic knowledge of energy changes involved when matter undergoes changes. Overall, the arrangement of topics in this course was to recognize the continuous macroscopic-microscopic interplay required to establish a recognized understanding in chemistry.

Another feature of the course was the inclusion of some applications and issues needed to enhance understanding and appreciate relevance of the topic being taught. For example, a salt dome for toxic wastes is used to enhance understanding of ionic bonds and to appreciate the importance of such knowledge. Molecular compounds are investigated when students are asked to make a report on the material currently being used in trash bags. The topic on stoichiometry included practical issues such as: "how car designers use stoichiometry to control pollution" and/or "air bag design in cars depends on stoichiometric precision" (Tocci & Viehland, 1996, p. 294).

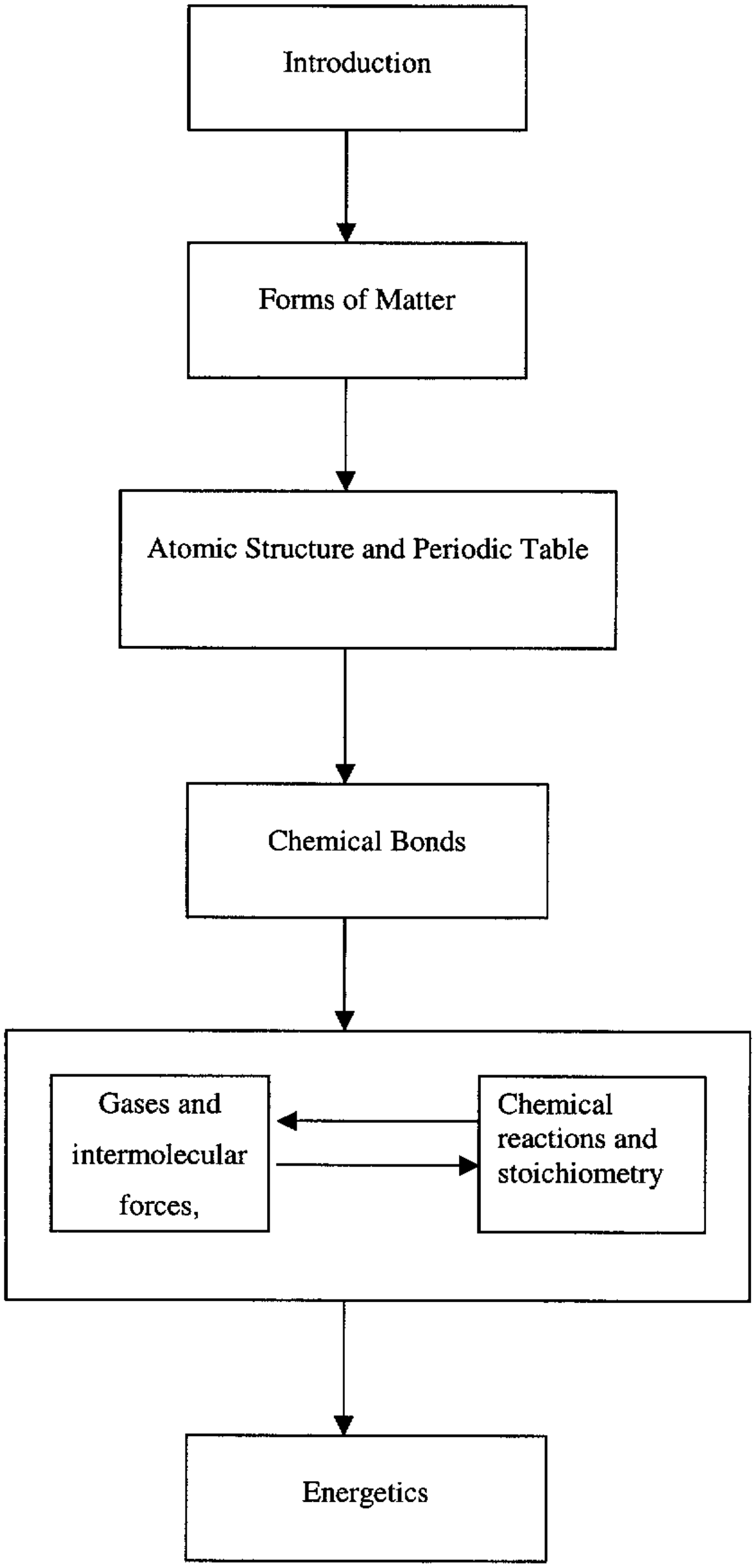

Figure 5.2
Sequence of topics and their relationships for Chem 4

Likewise, the trends in the periodic table are best understood and appreciated by students when taught using a story about the "Calcium supplement and medical mystery on George Decker's death" (Tocci & Viehland, 1996, p. 120).

The course sequence has proved challenging to the researcher, but it has been well received by the two instructors who initially implemented the new course, as noted in their journal records shown in Figure 5.3

Instructor G

> I don't have any complaints about the content sequence. The arrangement of the topics is more orderly than the old one. The topics are really connected; that is, you can't comprehend the next lesson if you have not fully understood the previous one. I believe that more practical applications should be included so that the students can really appreciate the theories they were learning. For example, the article on George Decker's Death elicited a nice response from the students. I like the discussion because the students were enthusiastic to give their own views. I think more of this type (a lesson applied in an article) should be given to the students. The discussion on the salt dome was very interesting, too. (Week 7; 01/00)

Instructor Q

> The course material was adequate, the content sequence was logical enough and the exercises adapted were reasonable. The inclusion of practical applications in the course material is one aspect that should be addressed if one is to achieve a more interesting and more meaningful lesson package for engineering students. The provision of practical applications and making them integral parts of the lesson is therefore a must. It is only through the inclusion of practical applications that basic chemistry concepts and the subject as a whole can be best understood and appreciated by non-Chemistry majors. Students found the reading on George Decker's Death very interesting and very informative. The lesson was straightforward.

The reading on Salt Domes was very interesting and very informative. Students were actively participating in the discussion. (Weeks 7 and 9; 01/00)

Figure 5.3

Instructors' journal records about implementing the new course

Both instructors affirmed the logical sequencing of the topics in the new course and would like to have more situational applications in their teaching because they themselves are learning much from the article. For example, the article on George Decker's Death dealt with the medical mystery behind the death of George Decker in relation to his ignorance about the physical and chemical properties of the metals he was working with. George could have been very careful in dealing with gold, silver, mercury and palladium if he had an opportunity to understand periodic trends of elements. Likewise, an understanding of the properties of salts could help students explain the advantages and disadvantages of using salt domes as a storage area for toxic wastes. Situational or practical examples like the salt dome and George Decker's Death arouse more interest in the lesson on periodicity of elements and in ionic compounds that are usually presented in a normal lecture mode.

5.1.2 The teaching scheme

The literature on teaching provides much useful information about current developments in classroom practice. Research results suggest that students generally experience improved learning when they are actively engaged in the classroom and when they construct their own knowledge following a instructional cycle paradigm (Farrell, Moog, & Spencer, 1999; Francisco et al., 1998). The course was built around getting students to work in and outside the class. Consequently, an important consideration was that the activities section in the course matrix included the instructional cycle approach consisting of three phases — plenary, seatwork activity, and closure or summary.

A plenary was a teacher talk or short presentation of new information, that is typically a lecture. For example, a 60-minute class session might begin with a 15-20 minute teacher-directed plenary. Simple problems could be presented and solved to illustrate the concept. Although the instructor remains the centre of the classroom, student participation was encouraged through class discussions. Leading questions could be asked to get students involved, guide their thinking about the pertinent chemistry concept, elicit feedback and verify their comprehension. Likewise this phase could be used to conduct a lesson review and reteach a topic when students misunderstood the lesson. The mini-lecture could be combined with an analogy, a story or demonstration that would prepare the students for seatwork.

The seatwork phase concerned learning tasks for students, where they worked on problems, questions, or activities either individually, in pairs or in small groups of 4-6 students in each group. The first few minutes were allocated to individual but guided practice. In this phase, the instructor moved around the classroom to ensure that the students were at work, to monitor student learning and to spot difficulties or frequent mistakes. Then a student faced a neighbour usually a seatmate (Kohler et al., 1997; Mazur, 1997) to discuss and apply the knowledge and skills, while continuing to receive assistance from the instructor. Finally, the instructor terminated the seatwork/activity phase after perceiving that most of the students had demonstrated understanding of the content or skill and conduct a closure or summary of the entire learning exercise. The closure/summary involved a 5-10 minute teacher-directed discussion with emphasis on the difficulties, common errors and misconceptions encountered by the students while doing the seatwork/activity. Homework could be given during this phase, or at anytime as the need arose.

One significant feature of the course was the integration of the instructional cycle into seven topics as shown in Table 5.1 which describes the expected frequency of each phase in the instructional cycle for each topic unit indicated in the course manual. Student work has the highest expected frequency (42.4%), followed by closure (29.6%) and then plenary (28.0%). This means that the key point in the course structure was for students to do seatwork tasks, to reduce long lectures and to provide feedback on student work. It was anticipated that students would learn better when they are actively engaged and thinking in class (Farrell et al., 1999).

Table 5.1

Expected frequency of the three phases in the instructional cycle in each topic

Topic Units	Phases in the instructional cycle			Total
	Plenary	Seatwork	Closure	
I. Introduction	4	8	4	16
II. Forms of Matter	6	9	7	22
III. Atomic structure and periodic table	5	13	8	26
IV. Chemical bonding; intermolecular forces; solids and liquid	16	28	17	61
V. Chemical equations and stoichiometry	15	15	14	44
VI. Gases and gas laws	11	15	12	38
VII. Energetics	9	12	8	29
Total	66(28%)	100(42.4%)	70(29.6%)	236

In each unit, the three phases in the instructional cycle were used. Unit IV: Chemical bonding, intermolecular forces and solids and liquids had the highest expected number of seatwork assignments with an almost equal number of plenary and closure. Analysis of the course material revealed that this unit has an estimated time allocation of 325 minutes, the most time among the topics. These topics are quite difficult to teach (Neiswandt, 2001; Schwartz et al., 1994) and most students have difficulty in understanding these concepts (Kirkwood & Symington, 1996). The need for more classroom experiences, with guidance from the instructor, could increase student understanding of these concepts at the micro level.

5.1.3 Sample description

Using an experimental course program, two instructors and their class were chosen to participate in a pilot course. The two instructors involved were members of the faculty in the Chemistry Department of USC. One instructor was a 25-year-old female with five years teaching experience, while the other instructor was a middle-aged male with ten years experience in chemistry teaching. Both instructors had a BS degree in Chemistry; the male instructor holds a Masters degree in Chemistry while the female instructor is currently pursuing her Masters degree in teaching chemistry. These two instructors, together with the researcher, also had attended the seminar on course development and this was the reason for the choice of instructors to implement the pilot course for Chem 4. In this study, the female instructor is called Instructor G and the male instructor is Instructor Q. The two classes assigned to Instructors G and Q were the only Chem 4 classes offered during semester 2, 1999-2000.

5.2 Changing How We Teach Chemistry

It is apparent that teacher learning is critical to maximise student learning. What teachers need to know and how they need to learn are critical pieces of the picture that results in student learning (Loucks-Horsley et al., 1998). Since teachers have the most direct, sustained contact with students and considerable control over what is taught and the climate for learning, improving teacher knowledge, skills and disposition through professional development is a critical step in improving student achievement.

Many critics assert that conventional professional development violates a number of key conditions for teacher learning (King & Newmann, 2000). The researcher's own experience in various faculty development activities provided by the University were short-lived resulting in weak implementation undermining enthusiasm and motivation. This approach resulted in teachers falling back on their traditional mode of delivering instruction. As Fullan (1991, p. 265) stated, "Nothing has promised so much and has been so frustratingly wasteful as the thousands of workshops and conferences that led to no significant change in practice, when the teachers returned to their classrooms." To ensure that learning and transfer from any development activities have long-term influence on the instructor's classroom performance, the seminar-workshop was followed by intensive guidance and coaching during implementation in the classrooms of the two instructors.

Coaching, when added as training procedure, virtually guarantees a successful transfer of almost any teaching approach being taught (Joyce & Showers, 1982). The process of coaching includes (a) provision of companionship which gives a reassurance that problems are normal, (b) giving technical feedback which ensures that growth continues, (c) analysis and adaptation which involves continuous examination of practice for appropriate use, and (4) facilitation that encourages interpersonal support to reduce isolation. When these coaching components are implemented effectively most and probably nearly all teachers will begin to transfer the new teaching model into their active repertoire. As Joyce (1982, p. 5) said, "Like athletes, teachers will put newly learned skills to use — if they are coached."

5.2.1 The course reconstruction workshop

The two instructors participated in the three weeks workshop on course development. Although both instructors did not directly prepare the course manual for Chem 4, they prepared an introductory chemistry course manual similar to Chem 4 for another Chemistry group. Instructor G prepared an introductory chemistry course manual for non-science major students (Chem 1a), while Instructor Q prepared the material for the second part of the General Chemistry course for engineering students known as Chem 14.

Chem 1a, Chem 4 and Chem 14 are all foundation courses in Chemistry for USC college students. Chem 4 and Chem 14 provide grounding in Chemistry to prepare engineering students for more formal study of science and technology. Chem 1a provides a basic Chemistry background that is appropriate and stimulating for non-science major students for whom this course would be their final formal Chemistry course.

The workshop enabled the instructors to be immersed in the orientation-activity-feedback model of teaching and learning, which was facilitated by a competent consultant. The workshop was an intensive, personalized three-week program, designed to guide and stimulate college science and mathematics instructors in USC to develop their own course manual that would increase the mental effort of students in and outside classrooms. Participants had the opportunity to learn through direct experience with the three phases of the teaching-learning model advocated in this study. During that hour, the consultant interviewed the course developer thoroughly on learning targets and on seatwork activities. Some of the questions were "Why do student have to learn that?, What is the importance?, How does this learning target relate to other targets?, What is a proper sequence?, How does the activity relate to the learning target? Does it really help?"

The workshop provided the instructors with opportunities to increase their understanding of the chemistry content which could enhance their ability to guide students in their content learning and explore the resources in the university to help them implement the reconstructed course that calls for new teaching methods. Further, the workshop developed and increased an awareness that teaching is not only teacher talk, but that student involvement was essential and that feedback should be given to help students be aware of what they are learning. In a way, the seminar-workshop provided the instructors with an overview on how to handle the course in the next semester implementation, assuring them that a coach would work closely with them.

5.2.2 Improving instructional skills through coaching

A variety of techniques have been recommended to enhance teacher adoption of effective teaching methods. One method, coaching by peers and/or experts, enables teachers to collaborate in developing, implementing and refining practices that maximise student performance in and outside the class (Showers & Joyce, 1996; Wolfe & Robbins, 1989). A growing amount of research indicates that coaching promotes changes in teachers' pedagogical practices (Showers & Joyce, 1996; Wolfe & Robbins, 1989), improves teachers' ability to plan and organize classroom activities (Munro & Elliot, 1989), uses effective teaching behaviours (Showers, 1985), and enhances teachers' ability to employ classroom behaviour management strategies (Pugach & Johnson, 1995; Vail, Tscantz, & Beviel, 1997).

Teachers often receive negative comments from administrators, peers and students during teaching evaluation. Indeed, evaluation can be tense because it involves rating or judging teacher behaviour, which could result in the teacher receiving feedback passively. From the perspective of peer coaching, the teacher is not an object to be observed; rather he or she is an active participant in the classroom visit (Eisenbach & Curry, 1999). "Peer coaching is a structured, formative process by which trained faculty voluntarily assist each other in enhancing their teaching repertoires within an atmosphere of collegial trust and candor" (Kinsella, 1995, p.111). Thus Kinsella's definition of peer coaching was slightly modified to fit into the definition of peer coaching established in this study. Peer coaching then is a semi-structured, formative process by which instructors work together and assist each other in enriching the chemistry course and enhancing teaching repertoires, within an atmosphere of collegiality.

Prior to the commencement of semester two, 1999-2000, an overview of the structure and organization of the Chem 4 course material was provided to the two implementers. During the orientation, the three phases in the instructional cycle, plenary-seatwork-closure, were emphasized for implementation in each class session. Classroom visits were conducted from the last week of November 1999 to mid March 2000. No class visits were conducted during long examinations, midterm and final examination days as the whole class period was allocated to students taking summative tests. After each classroom visit, the coach and instructor met in a ten-minute session for feedback and suggestions in employing the new instructional strategy. In some cases, the coach team-taught with the instructor upon request of the latter. Each month within the semester, the classes were videotaped. The SMEI project manager and the Department Chair visited the classes occasionally. The former provided written feedback while the latter gave his feedback verbally to the coach. All feedback, including video records, was discussed during the group's weekly meeting. A two-hour Saturday session was set for discussion on the course material, sharing experiences of implementation and preparation for the following week's class session.

The coach became a partner to each instructor, although the coaching relationship was more consultative than reciprocal. The next section describes how one instructor adopted/adapted the instructional cycle approach and eventually developed teaching skills through coaching. The other instructor was not included in this report because of various problems in his teaching that need serious attention and are beyond the domain of this study. Sources of data were the Instructor G's journal with narratives based on the questionnaire given, monthly video records of classes in the semester and the researcher's observation and conference journal.

Instructor G was a young female instructor in her fifth year of teaching. In her earlier teaching and really until the implementation of this course, she experienced serious classroom discipline problems in spite of her well-prepared and well-sequenced lessons. Such problems are quite common for about 40% of the University instructors, particularly with engineering students (Teacher Evaluation Report, 2000). Like other instructors, Instructor G was used to lecturing and asking occasional questions of students, or having a student complete a problem on the chalkboard. During the study, she taught two courses of introductory college chemistry; one for the non-science major students (Chem. 1a) and the other for engineering students (Chem 4). Being chosen to participate in the course development workshop, she was not only aware of her participation in the study but was expected to collaborate with the researcher in the implementation of the new Chem 4 course.

5.3 Effective Implementation of Classroom Routines

In the first week of teaching, the emphasis was on organizing the class. Objectives of the course and expectations from the students were presented by the coach. Ground rules on tardiness, attendance and bringing the textbook every session, were negotiated and agreed with the students.

5.3.1 Monitoring tardiness

As observed, tardiness was common in both classes. Latecomers disturbed both the teacher and the class during plenary and group work, because they continually asked questions on topics they had missed. Each session, about 6-10 students came in more than 15 minutes late despite the university's policy on latecomers. The policy allows students less than 15 minutes late to be admitted. Beyond that, students are registered as absent. A student with more than ten absences can be failed. Interviews with students indicated that one reason students were late was the successive schedule of classes at the College of Engineering. The building is about 150 meters from the third floor of the Science building, where Chemistry classes are held. It is a normal operating procedure that a warning bell is given five minutes before dismissal time. This is to give enough time for the students to transfer from one room to another. Despite these provisions, a substantial number of students keep coming late mainly because some instructors did not release students on time. Most students had identified this problem in the pre-project stage (Chapter 4).

To prevent tardiness in the class, the students and the instructor agreed the door would be closed and that nobody be allowed to enter the classroom after 15 minutes. During the first week of implementation of this agreement, two to three students came in late and insisted on entering. When asked the reasons for being late were, they cited traffic congestion, far distance of residence and oversleeping. The instructor considered these reasons invalid and so the students were denied entry. The next sessions had no latecomers, although the closing of the door after 15 minutes was still the practice until the end of that semester.

5.3.2 Monitoring attendance: A way to get acquainted with the students

The usual practice for knowing the students in a class is to have a seat plan. The seat plan is the basis for checking attendance of the students, usually done at the start of the period. In the experimental sections, the instructor found difficulty in knowing the students by their names using only the seat plan, particularly when seating arrangements were no longer followed during the group activities. The coach suggested nametags for each student. A nametag was distributed to each student so he or she could wear it during the class. Subsequently, each student upon entering the class got his or her nametag and wore it during the session. During the student activity session, nametags were useful in calling the attention of students who did not work on the activity immediately. It was also used in recognizing students who were actively and sensibly participating in the activities. At the end of the class, students were required to leave their nametag on the instructor's table, as this served as proof of their attendance in class. The use of nametags enabled the instructor to quickly call the students by name, and monitored student's attendance, without resorting to a time-consuming roll call.

Nametags served as one way of monitoring attendance and getting acquainted with the students. However, a problem was identified with the use of nametags. As observed, some students not only got their nametag but also the nametags of friends who were late and probably absent. The coach informed the instructors about this misbehaviour of students and both acted immediately by ensuring students took only their own nametag. In the beginning it was seriously implemented but as the course proceeded, the seriousness gradually declined because the instructors recognized the students.

5.3.3 Checking that students brought textbook to class

The usual practice of many instructors in the Chemistry Department was to inform students of the required textbook for Chem 4, by giving the authors' name and title of the book. No effort was made to check the student's textbooks and consequently books were rarely used during classes. As Mazur (1997) pointed out, it is important to get students to read the textbook and do part of the work ahead of the lecture. In the pilot implementation, effort was made to continuously check that students brought textbooks and used them for seatwork assignments in class.

At the start of the semester, students were required to obtain a textbook which was then used in almost every class session for student reference to their exercises and class activities, as well as for study of theory. More time in the class can be then spent on processing new information, rather than transmitting and note taking. The textbook was required to be brought to every session and a deadline of one month was set for the students to acquire a copy. Within this time frame, the coach explored the availability of the textbook and found that local bookstores were selling it at an affordable price. Likewise, the university's textbook department had enough copies of the books for loan within a semester at P 65.00 (about A$2.60) per semester which most students could afford. Moreover, the university science library had four copies: Two were in the reserved section for the students to borrow anytime and two were in the general reference for three-day loans.

After the deadline, the instructor checked the books of the students and to her dismay discovered only 12 students out of 50 had books. The instructor was irritated by this gesture and the coach and instructor agreed to remove students, who did not have books, from the class for that day. The action of sending students out was unpleasant for the instructor and coach, however, the risk had to be taken. Otherwise few students would participate during class activities or exercises. In the following class meeting, only three students out of 45 did not have books. From then on, the majority of students brought books to the class, though there were still students who did not follow the class because they forgot or lost their books.

5.3.4 Checking homework assignment

Homework is an outside classroom task given to students for continued and independent practice of skills started during the class and to prepare students for the next lesson. The usual practice was to seldom give homework assignments in Chem 4 courses. If given, homework assignments were used to get the students to read the topics for future discussion. Prior to the project, observation records showed that the most common homework task was solving problem sets, either provided by the teacher, or taken from the end of the chapter problem sets in the textbook. Checking the homework was rarely done and most often students did not work on their homework assignments. An interview with several students who had previously attended the same course (repeaters), confirmed this practice and one student's response is quoted below:

> Before I was not motivated to work on the homework. My teacher didn't check them. Sixty percent of my homework assignments done were copied from classmates and sometimes I let my classmates copy from me. Anyway, the teacher never read nor discussed the homework. Now, the teacher gave homework every session. The teacher had different ways of checking the assignment; either through a short quiz, random checking in notebooks or passing them on paper. (Interview with Student # 10; 23/02/00)

As stated by the student, the course manual developed for Chem 4 had homework assignments for every session which included reading certain pages in the textbook/references and noting down definitions of terms, solving exercises at the end of the chapter in the textbook, and answering practical questions in preparation for a class debate. There were two ways employed by the two instructors to check the assignments. One way was to give a 5-10 item quiz on definitions of terms or a brief description of a concept. The first quiz results showed that no student in both groups obtained the correct answers in all the questions given. Less than 40% of students (13 out of 38) got a partially correct answer meaning that key words were present but the logical presentation of the ideas were missing. Another way was to ask the students to write their assignment on paper and submit it, after which the instructor gave a follow-up discussion. However, the instructor seldom undertook the follow up.

5.3.5 Maintaining order in the classroom

At the start of the semester, both instructors had difficulty in controlling the class, particularly on the shift from the plenary to the activity and vice versa. Students tended to be noisy and chaotic during the activity and continued in the same way during the plenary sessions. To control the behaviour of the students, Instructor G would not start the discussion until the students were in order and quiet. At first, it seemed a waste of time waiting for students to become quiet. Eventually the students understood, when someone was talking, others were to listen. Instructor G had discipline problems before with other groups but, as the semester proceeded, her classroom control improved. The teaching method used in Instructor G's class assisted classroom control, as students were busy working on assigned activities. Good discipline was emphasised, particularly keeping quiet when somebody else was talking.

Conversely, Instructor Q had a chaotic method of teaching, never required silence, and therefore did not properly implement the instructional cycle and other features of the revised course. The disorganized classroom atmosphere observed frequently in Instructor Q's classes, despite the intensive coaching, indicated inadequate classroom management skills that require more special attention and beyond the domain of this study.

5.4 Implementing the Instructional cycle Model

In all classes observed and videotaped, the instructional cycle was implemented as the class-meeting scheme in the experimental class. Each class meeting consisted of one or more cycles of three phases—plenary, seatwork activity and closure or summary—discussed previously.

The emphasis of coaching was on the mechanics used in the classroom to implement the three phases in the instructional cycle. Initially the coach taught the class and in some cases, the coach team-taught with the instructor. Mirroring and modelling can heighten instructor awareness of the teaching approach (Showers & Joyce, 1996). Mostly a 10-15 minute conference with the instructor was used for coaching. Likewise, an hour long Saturday session with the two instructors also was conducted. The purpose of the weekly conference was to share experiences, using the questionnaire as a guide (see Appendix E) and to prepare the materials to be used for the following week's teaching.

5.4.1 The plenary phase

The plenary phase was recommended as 20 minutes. This time period included a quick and random homework check and used homework data as a link to the new topic or mini-lecture. Another strategy was to conduct a review of the past lesson by asking two or three 'what and explain' questions, to check previous knowledge and monitor understanding of students before reteaching was conducted. The other strategy was to present a concept map to inform students of the key concepts to be learned, followed by a mini-lecture. It was also useful to state lesson objectives so that students would know what was expected of them during the session. A video, a demonstration or an analogy also was suggested before a mini-lecture to motivate and sustain the interest of students. The later part of the plenary was normally an instruction to students on the next tasks.

The plenary phase consisted mainly of lesson review and a mini-lecture on a new topic. On few occasions, repeating quiz items or a handout and discussion of homework were also done in this phase. The instructor initiated lesson review and usually a recall of the previous lesson was done, either by asking questions or simply bring the previous lesson followed by stating the learning target for that session. The lesson review was often accompanied by questions from the instructor. A minimum of four questions and a maximum of 44 questions were asked by the instructors, as revealed by the five-videotaped lessons. Most of these questions were answered in chorus, indicating the questions were of low level. Some questions were answered individually. Students rarely asked questions. If a student asked, the question was to clarify or repeat a statement made by the instructor. After a month, choral answering in the class was minimised.

A mini-lecture was a form of plenary where the instructor introduced and described the content topic for the session. For example, the instructor directly enumerated the general properties of salts as made up of ions, having ordered packing arrangements, high melting and boiling points, being hard and brittle, and wrote these properties on the chalkboard. The instructor described each of these properties by stating definitions and giving an example for each property.

The instructor also used analogy or a story or demonstration in combination with a short lecture, as suggested in the course manual. For example, an analogy or a story of two entrepreneurs was used in the mini-lecture to visualise the concept of covalent bond which involves sharing of electrons (Tocci & Viehland, 1996). Sometimes a mini-lecture was followed by plenary instructions for students. The instructor further demonstrated a small part of the activity or illustrated a part of the seatwork. Sometimes a videotape was shown with questions or student activities integrated in the video session.

In the first two months of the pilot implementation, videorecords show Instructor G had 40-60 % of the actual time as plenary. This resulted in a shortage of time for seatwork/activity and almost no time for closure/summary. To remedy this situation, Instructor G assigned the unfinished seatwork as homework and had a homework check in the next session. Then a closure/summary was conducted before another cycle was again implemented. By mid-semester Instructor G had reduced the plenary to 20-30 % of the actual time.

Furthermore, video analysis revealed that in this phase there was little evidence that the Instructor G helped students establish a link with prior knowledge. The recall questions, which mostly called for stating definitions and facts, were asked to establish a link between the previous topic and the current topic. Instructor G provided insufficient thinking time, as questions came one after the other, even though some of the questions remained unanswered. The lengthy plenary session indicated that the instructor had difficulty in identifying important information to be included in the mini-lecture. Thus there was a lack of clear and concise directions given to the students before an activity was done.

5.4.2 The seatwork activity phase

The seatwork/activity phase was where the students worked on tasks either individually or in pairs. The time set for this phase was 30 minutes. Questions or problems could be shown on a transparency or taken from the course manual. The students could work individually or in pairs. The coach emphasized the immediate movement of the instructor around the classroom, to ensure that students started to work at the same time. The next round was to look at students' papers and start interacting with students, either individually or in small groups. At this point, the instructor could give feedback and corrections to guide students until most had learned the skill. Likewise, the instructor could note difficulties, problems, misconceptions, as well as good answers of students, for use as a springboard during the closure/summary phase. Good discipline had to be maintained during this phase and it could be attained by keeping the students at work, while the instructor continuously monitored them. Homework could be given during this phase, as an opportunity for independent practice of the skill.

Initially, students worked in groups of 4-5 but problems of discipline and wasting time were experienced. Later, Instructor G adopted grouping in pairs where students could face a seatmate whenever a task was to be done in groups. As suggested in the course manual, the instructor gave student tasks that were mostly taken from the textbook. Examples of student tasks were working on problems on chemical calculations, answering selected end of chapter questions, reporting on group discussion, board work, debate, reading a given handout and critiquing an issue such as global warming and pollution in the community. The most frequently implemented tasks were working on algorithmic problems and answering questions at the end of each chapter in the textbook.

In the early part of the semester, the class was noisy during the seatwork activity phase. Many students did not work immediately and other students did other things like writing a laboratory report. Some students pretended to work, but when checked, were not on task. While the students were on tasks, the instructor also went around the class, looked at students' work and continuously interacted, but the observation was of the whole class rather than of individual students or small groups. Immediately, one or two top achieving students were called to write answers on the chalkboard, while others were still doing their tasks. An uncontrollable noise emerged during this time, with most of the students stopping their tasks, copying notes from the chalkboard, and others holding conversations with a seatmate. As observed, the instructor felt awkward about imposing discipline on the misbehaviour of the students and thus had difficulty keeping the class in order. When this happened, the coach team-taught with the instructor to restore order in class.

The chaos in the class was due to problems such as inadequate time for students to work on the given tasks as they were not used to do doing this, they received vague instructions, and many students choose not to work because the activity was not graded. In the better schools in the Philippines, every student task is graded, leading to excessive grade consciousness rather than awareness of real learning. Other students were passive and found it awkward to participate in any group work. During the student interviews, many students admitted that they did not know what to do during group discussion. Others asked, "what is the use of working on seatwork when after a few minutes the answers are to be written on the chalkboard by top students." The coach helped the instructor facilitate the seatwork phase and monitor the students. The class was large — 50 students — and the instructor's initial experience was only in monitoring students individually or in small groups. Students who were misbehaving and not working during seatwork were identified and called after the class for a brief discussion of their problems. Sometimes a strong warning was given.

After two months of implementation and coaching, the seatwork phase was smoothly implemented due to Instructor G's good control of student discipline, adequate time provided for seatwork, clear instructions and students having their own textbooks. Likewise, the instructor interacted with students in pairs and constantly moved around to ensure that students were actively at work. As a result, more than 70% of the students were actively at work most of the time. Furthermore, the instructor took notes of errors, problems and difficulties encountered by students and discussed them during the closure/summary.

5.4.3 The closure or summary phase

The third phase of the instructional cycle was a closure or summary. A good closure could be achieved if the instructor had acquired the skill of noting difficulties, errors, problems, as well as good student work, while on task. Three teaching procedures were suggested to the instructor to be implemented in this phase. One was to provide feedback and discuss corrections. Next was to provide instructional reinforcement if necessary and the third was to give a brief correlation between exercises and objectives set for the lesson. Homework also could be given and good performance and discipline shown by students was commended during this phase.

Initially, the instructor provided the answers to questions or problems given during seatwork, or an able student provided the solution of a given problem on the chalkboard. The instructor either affirmed the students' solution or made some corrections. By mid-semester, the instructor tried to vary the presentation of this phase. Three or four students took turns in reporting results of seatwork or activities. The instructor began to ask other students to comment on peer answers but few students were involved in the interaction. However, the instructor encouraged students to interact by acknowledging good ideas or correct answers.

Instructional reinforcement was often conducted during the closure phase. These instructional reinforcements were given to point out common errors, misconceptions and difficulties encountered by the students during the seatwork phase and further illustrate with examples to correct the errors and clarify concepts. A recap of the activities was rarely done; however, homework was assigned as follow-up for the lesson.

5.5 Implications of the Pilot Study for Departmental Implementation

The purpose of the pilot study was two-fold. The goal was first to clarify whether the course manual could maximize students' intellectual engagement; the corollary to this was the feasibility of implementing the instructional cycle as the teaching scheme for the Chem 4 course. The second goal was to discover how the instructors would adapt the new course to examine problems associated with implementation and a faculty development program that would best fit the current conditions of the University of San Carlos.

The initial implementation of the new Chem 4 course gave a powerful learning experience to Instructor G and the researcher. The course manual was lauded for its detailed sequencing and logical arrangements of topics. The inclusion of practical applications was highly accepted and Instructor G recommended that each topic must include practical examples related to the subject matter being taught. Practical examples and chemistry demonstrations were used and not only as a source of facts but to stimulate student thinking. However, at this stage in the development of the course there was not enough of practical chemistry yet because instructors were still struggling with the basics of implementation. The monthly faculty workshops did emphasise demonstrations and visualisations but more abundant use will come in future cycles of implementation. The first revision of the course included these recommendations.

The use of the instructional cycle as the teaching scheme contributed not only increased student engagement, but also improvement of the teaching skills of the instructor. Initially, the instructor had a feeling of inadequacy in her teaching because she was unable to master the sequence of events stated in the course manual. She also felt awkward in her teaching because she lacked the necessary teaching skills to facilitate the new approach, particularly condensing information for a mini-lecture, managing engagement of students, monitoring and assessing student work and giving relevant feedback and controlling behaviour of students during shifts between phases. Other basic teaching tasks that the instructors had to cope with included checking textbooks, monitoring student tardiness and attendance, giving and monitoring homework, and maintaining order in the classroom. The instructor had not learned these skills during her previous lecture-dominated teaching.

Despite having a feeling of awkwardness in her teaching approach, Instructor G recognized that most students were frequently participating and generally engaged in the class. The instructor realized that shifting her role from a lecturer to a facilitator seemed difficult and she recognized the need to master the basic teaching skills first, before moving on to a complicated and wide ranging teaching repertoire. However, learning these skills came with relative ease due to adequate support extended by a colleague, who acted as an expert coach. As a result, Instructor G was confident enough to teach the course during the summer session, with 14 other instructors in the Chemistry Department taking turns observing her class over a period of five weeks. Many of the instructors had previously been her teachers.

CHAPTER 6
THE DEPARTMENTAL STUDY FOR RECONCEPTUALIZATION OF CHEM 4

6.0 Overview

This chapter describes the third and final stages of the implementation of the revised Chem 4 course. The main purpose of the third stage was to train 13 instructors in using more student-active teaching methods. The chapter begins with a description of the sample and the training undertaken by the instructors to orient themselves to the instructional cycle approach. Results and discussion of the experiences of the 13 instructors during the implementation of the instructional cycle approach, along with some case studies, also are reported. The chapter terminates with a discussion and summary of results.

6.1 Sample Description: The Instructors

There were 13 instructors and 14 classes involved in this stage of the study. Each instructor taught one Chem 4 class, except for one senior instructor who was given two Chem 4 classes. The instructors' experience varied from less than a year to more than 20 years of teaching chemistry and their ages ranged from 23 – 55 years. There were four male and nine female instructors. A profile of the instructors is found in Table 6.1.

The new Chem 4 course implemented during the pilot study was revised to include more practical applications and taught again in the summer from April to May. Instructor G (refer to Chapter 5) taught the course for six weeks from April to May 2000. During this period, 13 instructors in small groups took turns to observe the teaching of the new course. These observations served as orientation and training of prospective instructors for the next semester.

Table 6.1

Profile of instructors involved in final stage of the study

Instructor	Gender	Age	Number of years teaching	Highest degree attained
A	Female	40	4	BSc Chemistry
B	Female	33	3	BSc Chemistry
C	Female	53	25	MAT Chemistry
D	Female	40	5	BSc Chemistry
E	Male	38	8	MAT Chemistry
F	Female	45	20	MSc Chemistry
G	Male	25	3	BSc Chemistry
H	Male	23	0.5	BSc Chemistry
I	Female	56	27	MSc Chemistry
J	Female	52	25	MAT Chemistry
K	Male	23	0.5	BSc Chemistry
L	Female	35	12	PhD Chemistry
M	Female	26	5	BSc Chemistry

6.2 Training of Instructors

Before the start of summer in April 2000, the researcher and her Associate Supervisor were invited to a year-end faculty meeting of the Chemistry Department; the agenda was to inform the faculty of proposed changes in the teaching of Chem 4. The main goal of course reconstruction was to encourage students to work regularly in and outside class, which eventually could lead to better student performance and to take more responsibility for their own learning. Instructors G and Q, who were involved in the experimental implementation of the new Chem 4 course, reported their experience in teaching the course using the new teaching scheme. The positive reports of the two instructors and presentations by the researcher and Associate Supervisor persuaded the Chair and instructors of the Department to implement the reform to all Chem 4 classes in semester 1 2000, in June.

A 1.5 day seminar-workshop followed on April 14 and 15, 2000. Twenty instructors attended the workshop, although only 13 instructors were regularly teaching Chem 4. The other instructors, who were teaching chemistry courses for the chemistry majors, were interested to join the training as they needed the information on pedagogy to improve their teaching practice. Welcome behaviour from the instructors in the Department was their openness to the curriculum reform efforts.

The workshop began with individual's reflecting on their own practice and identification of practices that did not encourage students to actively work in class. This reflection was followed by a discussion in small groups about solutions to ineffective practices. One example cited was the improper use of seatwork and boardwork where the instructor gives a problem for the class to work on individually. As soon as a student comes up with an answer, usually the higher achieving student, the instructor immediately calls that student to show his or her answer on the chalkboard, while other students are still trying to solve the task. This method undermines the capability of students to work on their own because they resort to waiting for the answers to copy from the chalkboard which is a common practice in Philippine classes (Berg et al., 1998; Somerset et al., 1999). Other issues such students' perennial tardiness, poor attendance, no textbooks available in class, copied homework and the problem of maintaining student attention also were raised and discussed among the group.

The following day was allocated for the presentation and discussion of the new format of the course. The plan of activities for the summer training also was deliberated. The instructors were informed that the course presented a system of instruction that involved a instructional cycle consisting of mini-lecture, student seatwork and closure or summary phases. These phases were articulated in the course manual for instructors, which had been piloted and revised during semester two of the academic year 1999-2000. Each phase was discussed, including the important teaching behaviours, summarized in Figure 6.1, needed to implement effectively the instructional cycle (Good & Grouws, 1979).

A. Plenary (20 minutes)
1. review of past lesson, check on prior knowledge
2. check on homework
3. re-teach if necessary
4. present new topic or conduct a mini-lecture
5. motivate students by using demonstrations or analogies or videos
6. state the objectives of the lesson

B. Seatwork/Activity (30 minutes)
1. provide one or two questions/problems for students to work on
2. move around to get everyone to work
3. check if everyone has a textbook
4. look at students' paper and interact individually or in pairs
5. allow students to discuss their work with a seatmate
6. continue monitoring students and find out difficulties, common errors and problems
7. give feedback and corrections individually or in pairs
8. give homework as an opportunity for independent practice of the skill
9. control and keep students on task by moving around

C. Closure or Summary Phase (10 minutes)
1. provide feedback and discuss corrections
2. provide instructional reinforcement if necessary
3. give a summary of the session's academic exercise.

Figure 6.1

Important instructional behaviours required in the instructional cycle.

Each instructor was given a copy of the course manual for comments. The instructors were divided into four groups and each group was assigned two topic units. The task was to go over the course matrix and critique the sequencing of topics and whether the learning targets matched the activities suggested. Each group presented strengths and weaknesses of the course manual. The strengths included the detailed tasks for instructor and student, the inclusion of practical applications in most topics and an attempt to provide a reasonable sequence of topics. The areas in which the course manual had to be improved were logical sequencing of topics per unit, activities to be simple, direct and thought-provoking. Likewise, all activities had to be changed to fit into the new textbook recommended by the department so the workshop provided an opportunity for instructors to be involved in revision of the matrix activities due to the change of textbook. Thus the second revision of the course manual was a product of collaborative effort of the instructors in the Department which created a sense of collective ownership before the actual implementation.

Another training activity undertaken was an in-class demonstration of the new teaching approach. Instructors in small groups observed the Chem 4 class of Instructor G once a week for five weeks. Timetables were organized for a maximum of three visitors in the class. The most important aspect of class observation was to see the instructional cycle approach in action and the accompanying teaching routines that were needed for effective implementation of the teaching scheme. Likewise, observers were requested to maintain a written record of what they learned from the classroom events, with a particular focus on the three phases of the instructional cycle and on organization and management in the classroom. Figure 6.2 summarizes instructors' learning.

Plenary lecture phase

- I don't need to say all the things, which were in the traditional lecture, and thus less effort on the instructor. (Instructor F)
- A good grasp of chemistry content enabled the instructor to have a clear, systematic and brief plenary. (Instructors I, F and K)
- Topics were introduced in small bits so students could understand them with ease. (Instructors G).
- Instructors should learn to connect smoothly one topic to another and a cycle phase to the next. (Instructors C, H, and K)
- Avoid spoon-feeding. For example, giving homework, quiz on homework and then a plenary lecture on homework were redundant practices and sometimes promoted spoon-feeding. (Instructors G and F)
- Asking review or recall questions was a good check of student knowledge and understanding of the previous lesson. (Instructors C and L)

- Plenary must provide students with adequate preparation for the seatwork activity. (Instructors B, I, L, and H)
- Keep instructions for the next tasks clear and simple and at the level of student language. (Instructor I)

Seatwork activity phase

- An opportunity for students to apply the knowledge learned during the plenary lecture. (Instructors K and H)
- A good opportunity for the instructor to discover problems, difficulties and misconceptions of students which could not be done in lecturing. (All instructors)
- It was difficult to monitor 55 students within 30 minutes and at the same time interact with them individually or in pairs. (All instructors)
- I realized that I lacked these teaching skills: monitoring student work, assessing student performance and giving appropriate feedback. (All instructors)
- The use of exercises from textbooks can do away with time-consuming chalkboard written exercises. (All instructors)
- This phase made the students work. (All instructors)
- An opportunity for students to interact regularly with instructors and peers. (All instructors)

Closure or summary phase

- Wrap-up is needed to instil important learning targets each day. (Instructors C, G, I, and F)
- It is better to mention in recap whether the learning targets were achieved. (Instructor G)
- Homework was best given during this phase to give value to the connectivity between the day's task and the take-home task. (Instructors C, F, E, H, L and G)

About the instructional cycle approach as a whole

- This required careful preparation to establish alignment among plenary, seatwork activity and closure. (All instructors)

- An effective strategy to draw the attention and intellectual interest of students. (All instructors)
- The cycle could be implemented twice or more in an hour class session. (Instructors E, F, G, I, K and L)
- There has to be a change of instructor role from telling to facilitating. (All instructors)
- The need to build confidence not only on the pedagogical skills but also on the subject content. (All instructors)
- Lack of class management during shifts from plenary to seatwork and back (Instructors A, B, C, D, E, J, K, and M)

Figure 6.2

Summary of instructors' learning during in-class observation

Following the in-class observations, weekly meetings were scheduled when instructors actively shared ideas, identified problems and offered suggestions for some problems, based on their experiences. A lengthy discussion centred on three problems, namely, the troublesome and time-consuming implementation of classroom routines such as monitoring attendance, tardiness and textbooks, checking of homework assignments, and maintaining order in the class. One instructor pointed out the consequence when students were not allowed to enter the class if they were 15 minutes late and were sent out for failing to bring textbooks to class. The consequence could be that an instructor is held liable or answerable to whatever happened to a student outside of the class when supposedly that students should be attending his or her chemistry class. However, one instructor argued that university rules on attendance and tardiness must be explicitly implemented, while rules on textbooks and homework were agreed upon between the instructor and students. Table 6.2 summarizes the instructor solutions to various problems based on experiences.

Table 6.2

Problems identified when implementing class routines and instructors' suggested solutions

Problems	What could be done if I were to implement?
Tardiness	- I agree on the pilot strategy of closing the door for latecomers. - Latecomers may be called to make them aware of their tardiness. - Use seat plan to check tardiness every 5 minutes within the first 15 minutes of the session.
Attendance	- I support the nametag system but it needs close monitoring to ensure students get their own nametag only. - Implement the university policy on 10 % of the grade for attendance.
Textbooks	- Impose penalty (e.g., deducting 5 points from raw scores) for not bringing books, after setting the deadline. - Seatwork activities be done individually and to be collected.
Homework	- Spot-checking of the homework before the plenary lecture. - Use homework question or answer to link new lesson or reinforce lesson. - Sometimes collect the homework. - Sometimes give a brief check-up quiz about the homework. - Give homework every session as part of each student's independent practice of the knowledge and skill learned in class.
Controlling classroom behaviour	- Be a model in the class, listen alternatively when a student is talking. - Transfer talkative students to the front for easy access.
Leadership in maintaining and setting up the classroom	- Instructor's voice must be well projected to assert leadership and control. - I agree on pair grouping rather than a small group of 4-5 students. - Instructor should make a personal scheme to distribute her time equally to all students. - Consistent implementation of the rules and other agreements with the students.

The second problem was that instructors were worried that in one lesson it was impossible to check the work of all students, due to the large class size and the highly academically heterogeneous students; yet in their conventional lectures none of the students were checked. Arguments arose about this issue. One instructor suggested that monitoring students could be done by quadrant until the instructor had gained skills in assessing students and knew the students well. The facilitator pointed out that the instructional cycle approach could train the students to become more responsible for their own learning. An act of responsibility was to ensure their answers were right by comparing with a seatmate and textbooks.

The third problem was the physical set-up of the classroom that brought inconvenience in the mobility of instructors as well as students. The instructors unanimously proposed that teacher's platform be removed and chairs be unnailed. The chairperson supported the proposal and quickly acted on the request. The room renovation included not only the removal of teacher's platform and nailed chairs but air conditioners were installed in all lecture rooms. Overhead projectors also were made available and accessible in each room.

6.3 Departmental Implementation

Having been involved in the second revision of the course manual and undergone intensive orientation and training on the instructional cycle, 13 instructors taught the revised course in 14 parallel sections of first year engineering students. One instructor taught two sections.

Each instructor was observed at least twice and his or her classes were videotaped twice. The researcher, the content expert and the science education expert made observations that included the beginnings and endings of the lessons. Peer observations also were conducted after the mid-semester period where each instructor was asked to observe at least three colleagues. Weekly follow-up meetings with the instructors were held in small groups to explore teaching successes and dilemmas. The monthly discussion for all instructors covered materials such as content upgrading, effective classroom organization, establishment of classroom routines and behaviour management practices. Overall, the faculty development was geared towards helping and supporting instructors with the critical task of teaching.

Coaching began when the expert coach visited each class at least once a week for some instructors and almost every session for two instructors within four months. These two instructors made a request for the coach to team-teach with them when needed. After the mid-semester period, peer observation was implemented where each instructor was requested to observe at least two colleagues of their choice. The goals of the coaching program were three-fold. First, coaching was used to assist instructors in the implementation of the three phases of the instructional cycle in their teaching. As previously stated, for some instructors the coach had to team-teach in their classes. The second goal was to provide a mechanism so that instructors could receive regular feedback on their classroom performance. Good practices were affirmed and difficulties as well as problems were discussed and analysed for fine tuning in preparation for future teachings. The third goal was to facilitate the exchange of ideas, other instructional methods, and materials used during the implementation. This sharing of ideas and classroom experiences created a more positive collegial atmosphere in the Department, reduced isolation, and encouraged instructors to change gradually until improvements in teaching could be achieved.

Sources of data were videotaped lessons, narrative records of observations and student interviews. Videotaped classes were used to document the complex classroom behaviours while implementing the instructional cycle. The data also provided evidence about the length of time spent for each phase in the instructional cycle and student engagement. A checklist was developed to examine instructor conduct of a plenary lecture, seatwork activity and closure or summary. The instrument included a range of items based on the instructional processes learned in the training (see Appendix A). Likewise, teaching performance was analysed based on the list of key instructional behaviours (Rosenshine, 1983) required in the instructional cycle (see Table 6.2).

Three coders, who were not connected to the research project but trained in teaching, separately viewed the videotapes and coded the classroom events as indicated in the video coding matrix. Each coder viewed the videotapes independently to ensure that no discussion among them had occurred. The coder's tally was consistent with the researcher's tally, with a slight difference on time logs. For example, the three independent observers reported the actual lesson time as 70 minutes and 28 seconds while the researcher reported only 70 minutes. The latter realized the importance of reporting the specific time thus an average of time tallied was used in reporting time logs.

The researcher's journal records were in two forms. One form was a narrative description of class activities as well as instructor and student behaviours. The notes included the sequence of instructional activities along with instructor-student dialogue. The other form was a weekly and monthly summary of meetings of instructors. The summaries were examined for insights into the successes and problems of the instructors, various suggestions offered by peers to teaching problems, curriculum variables such as student academic tasks and course material, and the type of help or support that instructors received from peers.

The questionnaires that were administered towards the end of the semester asked for students' perceptions of their class and questions with regard to the teaching of the new Chem 4 course. Responses of these questionnaires are discussed in detail in Chapter 7.

Interviews of students were used to countercheck the responses of instructors and clarify situations described in the journal records to obtain a clearer picture of the data. These are all integrated in the presentation and analysis of data that follow.

6.3.1 Instructors adopting or adapting the instructional cycle approach

Changing the instructors' practice from lecture with the support of chalkboard and classroom discussion to a teaching style that incorporated more active elements in the classroom created a challenge of considerable risk for each instructor. As one instructor commented during a weekly discussion:

> In the past, my teaching was spontaneous but now with this style of teaching, I'm lost in the middle and many times caught asking myself these questions: What will I do next? Where am I now? So I had to look at the course manual every now and then. Anyway as time goes on I will learn and become familiar with the style. (Instructor I; 30/06/00)

Aside from departing from the widely accepted academic tradition of lecturing, instructors had to consider the trade-off in class time to cover course material and weigh the extent to which the students responded to the new approach. No doubt instructors were concerned about the amount of time used to incorporate the three phases of the instructional cycle into their class time. Teachers who can efficiently manage class time and have systematic classroom procedures have increased academic learning time in their classes — an identified benchmark of student achievement (Lin & Lawrenz, 1999). The comparison of the official allocated time for the course and the average of the actual time spent for teaching of chemistry by each instructor is shown in Table 6.3. Analysis shows that the amount of time wasted is estimated to accumulate a range of one hour to eight hours of teaching time lost within the semester. This amount of time lost may have contributed to the instructors being unable to finish the mandated syllabi.

Table 6.3

Time in minutes spent for actual teaching and time wasted

Instructor	Allocated time	Average actual time	Percent actual time	Average time wasted	Percent time wasted
A	90	62.7	70	27.3	30
B	90	75.0	83	15.0	17
C	60	55.3	92	4.7	8
D	60	52.0	87	8.0	13
E	60	40.0	67	20.0	33
F	90	68.5	76	21.5	24
G	90	79.7	89	10.3	11
H	60	30.0	50	30.0	50
I	90	86.0	96	4.0	4
J	90	63.3	70	26.7	30
K	60	43.0	72	17.0	28
L	90	70.5	78	19.5	22
M	60	39.0	65	21.0	35

As shown in Table 6.3 the instructors spent a considerable amount of time for actual chemistry teaching. However, a relatively large amount of time wasted (greater than and equal to 15 minutes) was observed for nine instructors. Unused time was caused by a majority of students coming to class very late, the instructor coming late and time given to students to settle and become quiet. Instructors D and G had moderately low time wasted (greater than 5 but less than 15 minutes). The relatively small amount of time wasted (less than 5 minutes) observed for Instructors C and I was solely caused by students in the whole class being late, as they had a previous class in the Engineering building, which is about 150 meters away from the classroom where Chem 4 was held. It was noted that instructors other than chemistry have also much more trouble with students from engineering coming late to class. But, instructors C and I had agreed rules and were able to manage the behaviour of students efficiently to make an early start to the lesson. Better utilisation of the actual instructional time was one important aspect of the study. The time spent by each instructor in plenary activity, seatwork activity and in closure or summary, as well as time spent in other academic activities is presented in Table 6.4.

Table 6.4

Time in minutes spent for each phase in the instructional cycle and percentage of each

Instructor	Average actual time	%	Plenary activity	%	Seat work activity	%	Closure summary	%	Other	%
A	62.7	70	38.9	62	17.7	28	5.6	9	0.5	1
B	75.0	83	25.0	33	34.2	46	13.6	18	2.2	3
C	55.3	92	22.3	40	17.4	32	8.9	16	6.7	12
D	52.0	87	30.4	58	10.2	20	4.4	8	7.0	14
E	40.0	67	31.1	78	4.0	10	3.0	7	1.9	5
F	68.5	76	19.5	28	35.4	52	12.4	18	1.2	2
G	79.7	89	25.3	32	52.2	66	1.1	1	1.1	1
H	30.0	50	11.7	39	6.6	22	7.7	26	4.0	13
I	86.0	96	33.6	39	37.3	43	14.2	17	0.9	1
J	63.3	70	25.4	40	26.8	42	10.6	17	0.5	1
K	43.0	72	19.0	44	11.0	26	8.0	18	5.0	12
L	70.5	78	9.0	13	30.5	43	27.5	39	3.5	5
M	39.0	65	21.6	55	10.1	26	6.1	16	1.2	3

It is apparent that all 13 instructors implemented the three phases of the instructional cycle following the suggestions in the course manual. Six instructors (B, F, G, H, I & L) utilised less than 40% of the actual instructional time for plenary activity. Three instructors (C, J, & K) had a range of 40-50% of the instructional time spent for the plenary, while four instructors (A, D, E & M) spent more than 50% of the actual teaching time for plenary lecture. Instructor E spent the highest percent of actual time (78%) for plenary activity. Instructors A, D, E, and M were observed to have classes which were noisy and these instructors made less effort in controlling student off-task behaviour.

Of the 13 instructors, six (B, F, G, I, J, & L) utilised a substantial range of time (40-60%) for seatwork activity, while five instructors (A, C, H, K & M) moderately allocated more than 20% but less than 40% of the actual teaching time for seatwork. Only instructors D and E had relatively little class time used for student seatwork activity in contrast to Instructor G whose major instructional time was utilised on students' seatwork tasks. Four instructors (B, F, G & I) were found to have good control of the class and no behaviour problems were observed. The associate supervisor and the content expert colleague in the department noted the same observations. Videotape records also showed that more than 70% of the students in these classes were continuously on task.

The highest percent of time spent for closure or summary was 39% by Instructor L. The videotape record as well as observations showed that the instructor not only gave feedback to the whole class about the task on seatwork, but also gave instructional reinforcement in the form of a mini-lecture. This observation was the same for Instructor H. The minimal time (less than 10%) spent for closure was implemented by Instructors A, D, E and G. The first three instructors (A, D & E) spent the time answering problems given in the seatwork, while instructor G used the time to emphasize common errors and briefly explain corrections of these errors. The other seven instructors (B, C, F, I, J, K & M) spent a range of 10-20% of the actual time for closure or summary.

Other activities included checking homework, giving homework assignments, checking attendance and reciting prayers, a standard procedure in the University, before and after end session. Four instructors (C, D, H, & K) spent 12-14% of the actual time for other activities. As observed, the instructors were spending more time on individual checking of homework rather than the random checking suggested during the training. Instructors E and L practised random checking of homework. The other seven instructors did not give much importance to checking the homework of the students.

6.3.2 Patterns across the 13 instructors

It was not surprising that 13 instructors chose to implement the instructional cycle as this was an integral part of the reform efforts. The instructional cycle, which consisted of three phases such as plenary lecture, seatwork activity and closure or summary, facilitated an environment where instructors could gradually change their role from telling to facilitating and students from being passively to being actively engaged in classroom tasks.

Table 6.5

Occurrence of selected implementation variables for 13 instructors in the plenary phase

Variable description	Instructors													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
1. lesson review	x	x	x	x	x	x	x	x	x	x	x	x	x	13
a. checks on previous lesson		x	x	x	x	x			x		x	x		8
b. help students link previous lesson with new lesson		x							x					2
2. conduct reteach because of			x											1
a. student questions														
b. students misunderstood the lesson														
3. a mini-lecture of new topic	x	x	x	x	x	x	x	x	x	x	x	x	x	13
4. style of lesson presentation														
a. uses a demonstration	x													1
b. uses an analogy							x		x			x		3
c. combination of lecture and question		x	x					x			x			4
d. combination of lecture and writing notes on the chalkboard				x	x					x	x		x	5
e. combination of lecture, questioning and writing notes on the chalkboard	x	x		x		x		x	x					6
f. view video or film								x						1
5. gives direction														
a. illustrates a part of the seatwork	x			x	x					x			x	5
b. demonstrates a small part of the seatwork activity														
c. direct instruction about the seatwork activity		x							x					2
6. gives clear and concise plenary lecture	x	x	no	no	x	x	x	x	x	x	x	x	x	10
7. asking questions	x	x	x	x	x	x	x	x	x	x	x	x	x	13
8. number of times plenary was conducted	1	2	1	1	1	2	2	1	2	1	1	2	1	

6.3.2.1 Procedures implemented in the plenary phase

The instructional behaviours of instructors during the plenary phase, as indicated by the 26-videotaped records, are summarized in Table 6.5. The table shows that six instructors implemented the plenary phase twice, while seven instructors had only one plenary within a class session. The table also indicates that the most common instructional behaviours included a) a lesson review (1), b) a mini-lecture of new topic (3), c) giving directions (5), and d) asking questions (7). The least common instructional behaviour was reteaching a topic or idea (2).

6.3.2.1.1 Lesson review

In the lesson review, eight instructors checked on the previous lesson by stating a brief description of the past lesson. For example, Instructor D started the lesson by saying:

> At the class last meeting we discussed about properties of matter. We also mentioned two types of properties, physical and chemical. Physical properties are identified without changing the identity of the material while chemical properties are characteristics that could be determined by altering the identity of the material. Class, what are examples of physical properties? (Observation; 30/06/00)

This time the instructor did not wait for the students to answer, but she continued saying,

> Physical properties could either be intensive or extensive. Intensive properties, as we all know, are dependent on the quality or kind of the material while extensive depends on the amount or quantity of the material. Properties of matter are useful because they give us an idea about the use of the material. Is there any question class?

The students chorally responded, "No". Then the instructor said, "Today we are going to discuss the classification of matter. Okay, get your book and open it to page 7". Then a seatwork activity followed.

In the example stated above, the instructor was making a summary of the topic discussed in the previous session. Her purpose, as revealed during a post-observation conference, was to remind her students of the past lesson in order to establish a link to the new lesson. She believed that doing the summary by herself is faster than asking a student to do so and then activities suggested in the course manual could be fully covered and implemented. She also pointed out that giving a summary of the past lesson is one way of allowing students to settle down.

Another way of lesson review, implemented by two instructors, was to help students establish a link between the previous lesson and the new lesson by asking questions or providing clues. A video transcription of a lesson conducted by Instructor I illustrates this method.

Instructor I began the session by making a spot check on the homework assignment which was about predicting the use of the materials based on the set of properties given. While she moved around the classroom, a student was requested to write his homework assignment on the chalkboard. After the spot-checking she said "Alright, only three students in this class did not work on their homework task and I'm warning them, the rest of you are good students. Okay, Charles will you please explain what you have written on the board." Charles stood up and was about to start when the instructor interrupted saying "Please be reminded that you are not allowed to shout your answer or any word when somebody is talking. Just raise your hand if you would like to say something. Okay, go on Charles". Charles presented and discussed a table showing a list of materials, their properties and uses. Then the instructor said, "Good work Charles. Any comment or reaction on the examples presented by Charles? Is it clear and do you understand?" Everybody responded in the affirmative.

The instructor continued and said, "Now that you know that knowledge of properties of matter helped us determine the use or uses of a material, what else can we benefit from knowing the properties of matter?" There was a 20-second silence and the instructor said "Do you still remember our activity last meeting where you were asked to group the objects according to their similarities?" A student raised her hand and the instructor said, "yes Anna". Then Anna stood up and responded, "I know

now Maam, knowing the different properties of matter would be easier for us to classify materials". "Very good, commented the instructor. Today we will have an activity on classifying matter. Open your book on page 7". Then the seatwork activity continued.

Classroom observations support this videorecord where Instructor I implemented an interactive plenary. In the lesson, the instructor asked questions to provide a clue so that students could remember past knowledge and bring it forward to use in considering a new lesson. During the post-observation conference, this instructor emphasized her belief that instructors, being the centre of learning in the classroom, should be able to control what the students are doing and direct them to a certain goal. In this case, the instructor's questions had led students to establish a link between properties of matter and classification of matter. The response made by the students gave the instructor information about students' progress, which was indicated by the positive acknowledgement remark, and could also be interpreted as a reflection on the effectiveness of the instructor's own way of implementing the plenary.

Both the video records and classroom observations indicated that a lesson review was always followed by a mini-lecture of the new topic. A mini-lecture was presented in various ways; six instructors used a lecture in combination with questioning and writing notes on the chalkboard, five employed a combination of lecturing and writing notes on the chalkboard, and four used a combination of lecturing and asking questions (see 4c-e; Table 6.5). Only three instructors used analogy, demonstration, and videos to present a lesson (see 4b; Table 6.5).

6.3.2.1.2 Giving directions

Giving directions also was common to seven instructors, where five of them made the direction specific by illustrating a part of seatwork activity (see 5a; Table 6.5). For example, Instructor J illustrated the solution of one question in the problem set intended for the seatwork activity. The topic being discussed in this class was about the ideal gas law. The seatwork activity was to solve Exercises 10.35 a-b and 10.40 (Brown, LeMay, & Bursten, 1997, p. 376). Before the students could work on the given problem set, Instructor J illustrated one question in the problem set. His sample solution for Exercise 10.35a is shown in Figure 6.3.

(a) Given: $P = 0.96$ atm
$T = 35\ °C$

Find: d $SO_3(g)$

Solution:
MM $SO_3 = 80.06$ g/mole
$T = 35\ °C + 273 = 308\ K$

$$PV = nRT$$

$$PV = \frac{g}{M}RT$$

Rearranging: $\frac{PM}{RT} = \frac{g}{V}$ and $d = \frac{g}{V}$

$$\text{So, } d = \frac{PM}{RT} = \frac{80.06\,\frac{g}{mol} \times 0.96\ atm}{0.0821\,\frac{L\text{-}atm}{mol\text{-}K} \times 308\ K} = 3.0\,\frac{g}{L}$$

Figure 6.3

Instructor J's solution to exercise 10.35a

The practice of Instructor J contrasted with the practices of Instructors B and I who did not illustrate a part of the seatwork but just gave direct instruction to students by saying, "For your seatwork; solve the problem numbers 6.67-6.68 page 219 (Instructor B) and 3.67-3.69a page 103 from your textbook" (Instructor I). When asked during a small group meeting about these practices, Instructor J's response was,

> I just wanted to ensure that students' were given adequate guidance while answering the seatwork assignment. It is difficult to monitor each of the 50 students during the seatwork activity phase, so the various sample solutions given could guide students in their work. (Small group session, 11/07/00)

Instructors B and I, on the other hand, argued by saying, "We don't want to spoon-feed the students". Instructor I further justified her practice by saying,

> Giving more examples is spoon-feeding and could take more time. Anyway during seatwork phase, I check students' work and correct errors in their solution. Students must be given chance to work on their own and not always depend on the instructor. Isn't it that this is the purpose of this new teaching method; to let the students work? (Small group session, 11/07/00)

Instructor B did not elaborate her reason.

Instructors J, B and I had different topics during the videotaping of their classes. Instructor J discussed the ideal gas law while Instructors B and I dealt with topics on orbital notations and limiting reactants, respectively. In the course manual, these topics have seatwork assignments that are derived from the end-of-the-chapter questions. The course manual also contains complete solutions to all the suggested problem sets for seatwork activity. The three instructors had followed the exercises suggested in the course manual but they differed in their mode of giving directions because their beliefs and level of experiences were also different. Instructor J, being a neophyte instructor and could belong to the mechanical category of teachers (Bybee, 1980), had experienced difficulty in individually monitoring his 50 students during the seatwork activity phase, and so his decision to illustrate a part of the seatwork is one way of giving the students the needed guidance to work for themselves.

On the other hand, Instructors B and I had a view that giving more examples is spoon-feeding and Instructor I stated that she would not like to lengthen her lecture time by showing more examples because reducing lecture time is emphasized during the coaching sessions. Instructor I's action showed determination to adopt the new teaching method and probably the continuance of using the instructional cycle model could move her into the routine category of teachers (Bybee, 1980). Instructor B did not explain that her action seemed to be undergoing some disequilibrium about her teaching practice. Obviously the three instructors gave directions before any seatwork activity was conducted; the timing in which these directions were given depended on the level of experience, skill and background of the instructors. What mattered most in the actions of the three instructors was that they were beginning to be conscious of reducing their lecture talk and time.

6.3.2.1.3 Asking questions

The most predominant instructional behaviour was asking questions. Questions were often used during lesson review, conducting mini-lectures and even on demonstrations and analogies. It is interesting to note from Table 6.6 that the maximum number of questions asked by the instructors during the plenary phase ranged from 22-34 whereas in the pre-project study (Chapter 4) the ranged was 32-74, while the minimum number of questions asked ranged from 3-12 whereas before this project the range was 9-17.

Table 6.6

Number of questions during the plenary phase

Instructor	Variable descriptions							
	Instructor's questions				Student's questions			
	Number of questions asked	Number of questions answered by			Number of questions asked	Number of questions answered by		
		in chorus	indivi-dually	instruc-tor		a class mate	the instruc-tor	student himself/ herself
A	23	13	10	0	0	0	0	0
B	12	3	9	0	0	0	0	0
C	12	5	7	0	1	0	0	1
D	12	2	9	1	0	0	0	0
E	23	1	5	7	0	0	0	0
F	34	11	21	2	0	0	0	0
G	22	5	17	0	6	3	3	0
H	8	3	5	0	0	0	0	0
I	25	12	13	0	0	0	0	0
J	3	2	0	1	0	0	0	0
K	29	22	3	4	0	0	0	0
M	8	3	5	0	0	0	0	0
L	3	1	2	0	0	0	0	0

The comparison of the number of questions asked by the six instructors, who participated both in the pre-project and departmental stages of this study is presented in Table 6.7. The data in Tables 4.4 and 4.5 were compared with the data in Table

6.6 of this chapter because in the pre-project stage the instructors were both in their natural (unannounced video) and in their maximum performance or best practice (announced video).

Table 6.7

Comparison of number of questions during the pre-project and departmental stages of the study.

Instructor	Number of Questions Asked		
	Pre-project stage		Departmental Stage
	Unannounced video	Announced video	
A	41	39	23
B	39	43	12
C	68	42	12
D	17	27	12
E	41	52	23
F	74	12	34

Analysis indicated that there is a sharp decrease on the number of questions asked by each instructor. The reduction of the number of questions could have followed the reduction of the lecture time when the instructional cycle model was implemented. An exception to this trend is noted for Instructor F, which indicates an increase of the number of questions asked from 12 to 34 despite the emphasis on reducing the lecture time during the coaching session. Added to this opposing trend, was the data shown in Table 4.3 (Chapter 4) and in Table 6.4 (this chapter). Table 4.3 shows that Instructor F had a plenary time of 37.4 minutes during the pre-project stage but had 19.5-minute plenary during the departmental implementation. To summarise, Instructor F had asked 12 questions within 37.4 minutes during the pre-project stage and had asked 34 questions when she implemented the instructional cycle as the teaching approach. These data revealed by Instructor F's questioning is in conflict with the generalization made earlier that the reduction of lecture time enabled the reduction of the number of questions asked.

Since this conflict arises, the researcher reviewed the videotapes of teaching of Instructor F. It was noted that in the pre-project announced videotape, Instructor F had implemented the plenary-seatwork-closure or summary phases in her teaching but the plenary phase was characterized by boardwork where a student solved a reaction rate law problem on the chalkboard and made a report to the class while other students were copying the answers written on the board. The instructor did not make any long talk during the 37.4-minute plenary session because a student did most of the talking. Instructor F as an alternative to the lecture method employed boardwork; however, the method did not invoke many students to be mentally active. Conversely, the videotape of classes recorded during the departmental stage shows that Instructor F's 19.5-minute plenary session was made interactive through questioning. This finding was confirmed by the associate supervisor when he said to the researcher after his observation with Instructor F's class, "I will not go back to her class anymore because I am satisfied with the teaching procedure. She's good".

The analysis also revealed that the majority of the questions asked by the instructors were answered individually, although a substantial number of questions were answered in chorus (Table 6.6). A comparison of the percentage of questions answered chorally as well as individually during the pre-project and departmental stages of the study is shown in Table 6.8. The comparison is limited to the six instructors instead of 13 because only six instructors participated in both pre-project and departmental stages of this study. Likewise, only the data for the pre-project announced videotaping are compared to the departmental stage data because the instructors are presumed to have good preparation and be performing at their best having been aware of the videorecording as well as being conscious about their implementation of the instructional cycle model in their teaching. Despite these limitations, a trend could still be generated and explained.

Table 6.8

Comparison of percentage of questions and the mode of answers during the pre-project stage and departmental stage

Instructor	Percentage of questions and mode of answers					
	Pre-project stage			Departmental stage		
	Chorally answered	Individually answered	Instructor answered own question	Chorally answered	Individually answered	Instructor answered own question
A	66.7	25.6	7.7	56.5	43.5	-
B	46.5	39.5	14.0	25.0	75.0	-
C	57.1	21.4	21.5	41.7	58.3	-
D	51.9	18.5	29.6	16.7	75.0	8.3
E	69.2	15.4	15.4	21.7	47.8	30.5
F	50.0	25.0	25.0	32.4	61.8	5.8

The choral answering of questions is higher in the pre-project stage than in the departmental stage and this trend is reversed when questions were answered individually. This means that before the instructional cycle model was introduced, instructors' questions were mostly answered in chorus and few questions were answered individually. Classroom observations also indicated the high tolerance of instructors to acknowledge one or two worded answers shouted simultaneously by most students. This habit was common to all the instructors observed, in fact, even in other classes in many schools in the Philippines (Berg et al., 1998; Somerset et al., 1999). Perceiving that the choral answering practice invoked classroom disorder and proliferating low level of thinking, the coach emphasized that instructors should wait for a student to answer or call on a student if no one volunteered to answer. Individual answering of questions provides the student with opportunity to explain his/her views and for instructors to ask thought-provoking questions.

In the departmental stage, the analysis showed that most of the questions asked by the instructors were answered individually. An exception emerged for instructor A having a slight difference favoring the choral mode of answering questions. This trend could have been influenced either by instructors now being conscious of asking questions that solicit explanations or having realized that a choral answer triggers students to be noisy and prevents them from thinking critically. Classroom observations indicated that most of the questions were intended to engage students in recitation and check students' understanding by looking for short and specific answers. Few questions stimulated ideas and led students in brief discussions.

The associate supervisor had noticed these features of individual questions while observing a lesson on changes of matter conducted by Instructor C and his report stated:

> You have many nice questions. I particularly liked the series of questions on chemical and physical change and how you recalled the laboratory experiences and then concluded that there was strong evidence for chemical change but that the evidence was not absolute (100 %). So the teacher-dominated part of the lesson went very well with clear explanations, much interaction and good questions and a reasonably quiet classroom atmosphere. (Observation report: 11/07/00)

In the case of Instructor A, the anomaly to the general trend mentioned earlier, the questions were observed to have focused on definitions (e.g., what is ionisation energy?), stating rules (e.g., state the trend on electron affinity within a period), and enumerating facts (e.g., which has bigger atomic size Cesium or Bromine?). These questions are designed to identify students' knowledge of basic information to understand the trends in periodic properties. However, the frequent tolerance of the instructor to acknowledge short responses in chorus made the questions unchallenging and low level.

Questioning provides the instructor with a tool to assess his or her students' level of understanding and allows him or her to encourage students to participate in their own learning (Byers, 2001). Multiple levels of questions engage students in recitation, in telling information, explanation and in discussion (Rosenshine, 1987). The choral answering of questions indicated that questions required only one or two worded answers, implying that instructor questions were low level. Low level questions call for simple recall and enumerating facts (Byers, 2001).

Students on the other hand rarely asked questions. Only instructor G generated six questions from the students. Three of these questions were answered by a classmate and the other three by the instructor. As observed, the three questions from the students gave an impression that student-student interaction was encouraged in this class. The three questions answered by the instructor were questions about clarifying mathematical manipulations and no student in the class volunteered to answer, thus the instructor was compelled to answer with an explanation. A similar situation happened in the class of Instructor C.

6.3.2.2 The seatwork activity phase

The new course highly recommended the allocation of more time for the seatwork activity phase so that students could be continually engaged in class. In the videotaped records within the semester, it was noted that seven instructors implemented the seatwork activity phase twice and six instructors conducted seatwork only once within a class session. The most common form of seatwork activity was an individual task for students and was regarded as guided practice on knowledge and skills (see 3e1; Table 6.9). Seatwork activities were non-graded. Other variable descriptions involved in the seatwork activity phase are summarized in Table 6.9.

As can be seen, there were three behaviours exhibited by the instructors during this phase (see 3d; Table 6.9). The most popular one was the instructor circulating around the classroom; nine instructors quickly moved around the classroom to ensure that the students started the task immediately and to ensure that every student was on task. All of the 13 instructors moved around and looked at student's work. This was done to identify learning difficulties, misconceptions and errors about the subject matter being learned.

The next popular instructional activity done by the majority of instructors was giving feedback, by interacting with students either individually, in small group or as a whole class. However, instructors interacted with the students individually and a few of the instructors interacted with students in a small group (see 3e1, 3e2; Table 6.9). Six instructors interacted with students as a whole class while the latter were on task (see 3e3; Table 6.9). Whole class interaction can be a bad teaching practice because it could distract student focus from the seatwork task and often led to confusion. No instructor exhibited bad teaching habits such as checking students' test papers, or leaving the room while the students were on task. In the Philippine setting, seatwork with laboratory work is often an excuse for the instructor to either do nothing or leave the room (Berg & Saniel, 1996).

The third instructional activity, which was conducted by seven instructors, was writing or posting seatwork questions or problems on the chalkboard (see 3a; Table 6.9). It was observed that these instructors had few students bringing textbooks to class. Four of these instructors were observed to have written notes on the chalkboard while the seatwork activity was in progress (see 3f; Table 6.9). For example, the notes included a stepwise procedure on how to write a balanced chemical equation or write a Lewis structure of a covalent compound. One instructor claimed that it was necessary to write notes on the chalkboard to guide the students in working with a given problem set. However, when the researcher looked at the textbook, it was found that these procedures were in the book. If the instructor had required the students to bring textbooks to class, the instructor could have used the time to monitor and interact with students, rather than using class time to write notes on the chalkboard.

Table 6.9

Occurrence of selected implementation variables for 13 instructors in the seatwork activity phase

Variable description	Instructors													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
1. number of times conducted	2	2	1	1	1	2	2	1	2	2	1	2	1	
2. form of seatwork														
a. individual	x	x	x	x	x	x	x	x	x		x	x	x	12
b. pair										x				1
c. small group (3-6 students)														0
d. graded														0
e. non graded	x	x	x	x	x	x	x	x	x	x	x	x	x	13
3. instructor's behaviours														
a. writes questions or problems on the chalkboard		x		x	x	x		x		x		x		7
b. moves around to ensure that students start immediately		x	x		x	x	x		x	x	x	x		9
c. moves around to ensure everybody is at work		x	x		x	x	x		x	x	x	x		9

Table 6.9 (continued)

Variable description	Instructors													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
d. goes around and look at student's paper	x	x	x	x	x	x	x	x	x	x	x	x	x	13
e. interacts with students														
1. individually	x	x	x			x	x	x	x	x	x	x	x	11
2. in small group				x		x								2
3. as a whole class		x	x		x					x	x	x		6
f. writes notes on the chalkboard			x	x								x	x	4
g. prepares materials such as OHP and VHS														
h. sits and does other work like checking papers and reading														
i. leaves the room														
j. other														
4. students' behaviour														
a. answer the questions or problems written on the chalkboard or transparency (non textbook problem)		x				x		x				x		4
b. read a topic from a textbook			x						x		x			3
c. answer questions or solve problems in the textbook	x		x	x	x	x	x		x	x	x	x	x	11
d. solve situational problem														
e. interpret a given data, construct graph and make an inference														
f. perform a short experiment or demonstration														
g. make a concept map														
h. discuss the answer/ideas with a seatmate or within a group		x	x			x	x		x		x			6
i. write answer or solution on the board (boardwork)	x	x				x			x	x	x	x		7
5. percent (estimate) of students who were actively at work most of the time														
a. more than 70 %	x	x	x			x	x	x	x		x	x		9
b. 41-70 %				x	x								x	3
c. 10-40 %										x				1
d. less than 10 %														

Regarding student tasks, the most common was answering questions or problem sets taken from the textbook. This meant that 11 of 13 instructors used the seatwork activity suggested in the course manual (see 4c; Table 6.9) and only four instructors opted to give problems or questions, other than those in the course manual or textbook (see 4a; Table 6.9). These problems were either written on the chalkboard or displayed on an overhead transparency.

Another task for students, which was implemented by six instructors, was an opportunity to discuss answers to the given questions, solutions to the problem set or an exchange of ideas and thoughts after reading an assigned topic (see 4h; Table 6.9). Pair or small group work offered an opportunity for students to learn from the questions, suggestions and ideas of a peer. Students indicated during interviews, that discussion with peers was favoured because they were able to formulate thoughts and share their ideas within a small group or with a partner, with less chance of being ridiculed than when sharing ideas with the whole class. Some comments from students were:

> I like to argue with my classmates and to share ideas with them. (Charles, 25/02/00)

> I learn from my seatmate, she is better in letting me understand the topic than my teacher. (Shyrra Lou, 18/02/00)

> I don't like oral discussion in front of the class because my classmates make fun of my English. (Eric Jay, 02/02/00)

Seven instructors, as one of the student activities, employed boardwork during the seatwork phase (see 4i; Table 6.9). This activity was limited to putting answers on the chalkboard when most students had finished the task, although three instructors used boardwork in the traditional way. Traditionally, boardwork is done where one or two students, usually the good ones, are actively participating and many students just copy notes from the chalkboard, although they are expected to do the problems themselves.

One good feature of the seatwork activity phase was that the majority of students was actively on-task most of the time (see 5; Table 6.9). Nine instructors had more than 70% of their students continuously on task, while four other instructors had less than 70%. The low involvement of students of the four instructors was primarily due to the inability to monitor consistently the students' work and some problems involving classroom management.

6.3.2.3 The closure or summary phase

The closure or summary observed occurred at various times during the lesson. Generally, this happened right after a seatwork activity when the instructor gave feedback on learning difficulties, common errors and misconceptions of students. Video records showed that ten instructors conducted closure once and three instructors conducted this phase twice during the lesson and one instructor, K, conducted closure three times (see 1; Table 6.10). Like the plenary phase, this phase was also an instructor-led activity. The instructional behaviours observed during the closure or summary phase are summarized in Table 6.10.

Table 6.10

Occurrence of selected implementation variables for 13 instructors in the closure or summary phase

Variable description	Instructors													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
1. number of times closure/ summary done	1	2	1	1	1	1	2	1	2	1	3	1	1	
2. instructor's behaviour														
a. reads the seatwork questions and immediately answers each				x				x				x		3
b. writes the answers on the chalkboard		x	x	x	x		x					x		6
c. encourages students to react to one another					x	x						x		3
d. reacts on the answer/response of student	x	x			x	x	x	x	x	x	x	x	x	11
e. discusses common errors/misunderstandings of concepts discovered during seatwork (corrective feedback)			x				x		x	x	x			5

Table 6.10 (continued)

Variable description	Instructors													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
f. conducts instructional reinforcement		x	x			x	x	x	x	x	x	x	x	10
g. gives summary of session's academic exercise			x			x	x	x			x			5
h. relates this discussion to the previous (p) or next (n) lesson									x	x (n)	x (n)			3
3. student's behaviour														
a. presents orally the answers to the seatwork questions to the class						x	x	x						3
b. gives oral report about the seatwork activity to the class														
c. discusses board work	x	x							x					3
d. summarizes the activity														
e. other (specify)*	Bw	Lcn	Cn	Bw	Bw	Bw	Bw		Bw	Bw	Bw	Bw	Bw	Bw

* Code used: Bw (Boardwork); Cn (Copy notes); Lcn (Listen and copy notes)

The instructional behaviour popular amongst the 11 instructors was an immediate reaction to the answers or responses of students (see 2d; Table 6.10). This instructor reaction was spontaneously given just after a student gave an answer or had done the boardwork. The reaction often led to giving instructional reinforcement which was perceived by the students as another plenary lecture. Six instructors wrote answers on the chalkboard as a closure strategy.

Other techniques employed by five instructors were giving corrective feedback and a summary of the session's academic exercise (see 2e, 2g; Table 6.10). Corrective feedback was a class discussion on common errors and misunderstanding of concepts discovered during seatwork activity. Few instructors exhibited behaviours such as reading seatwork questions and immediately answering them (see 2a; Table 6.10), relating closure discussion to previous or next lesson (see 2h; Table 6.10), and encouraging students to react to one another (see 2c; Table 6.10). Likewise, only three instructors implemented a student-led closure or summary phase. The most common student-led closure phase included a student oral presentation of the answers to the seatwork questions (see 3a; Table 6.10), doing boardwork, and discussion about the boardwork (see 3c; Table 6.10). There was no instance where students gave an oral report about the seatwork activity to the class or students gave a synthesis of what they learned from the academic exercise.

As indicated previously, this closure phase was dominated by most instructors who conducted the discussion with a number of questions frequently asked. The frequency of questions asked by the instructors and how these questions were answered are shown in Table 6.11.

Table 6.11

Number of questions asked by the instructors during the summary or closure phase and the manner of students' answer

Instructor	Variable Descriptions			
	Number of questions asked	Number of questions answered		
		in chorus	individually	by instructor
A	0	0	0	0
B	8	1	7	0
C	10	5	4	1
D	14	7	2	5
E	2	1	0	1
F	19	17	1	1
G	4	4	0	0
H	7	4	1	2
I	20	9	5	6
J	6	4	0	2
K	12	11	1	0
L	6	1	4	1
M	3	1	1	1

Four instructors asked a range of 11-20 questions while eight instructors had a range of 2-10 questions asked during a 5-10 minute closure phase. As in the plenary, the majority of these questions were chorally answered and almost all the instructors tolerated such practice. Although most of the questions were used to check constantly students' understanding of the content, some questions were answered by the instructors themselves. It could be viewed that most instructors tended to use the closure or summary phase as another lecture session. Students' perception both in the interviews and in the questionnaire confirmed these behaviours and these are discussed in Chapter 7.

6.3.2.4 Homework assignment

Another important component of the instructional cycle approach was homework. Though the course manual contained suggested homework assignments for the instructor to use, the instructor was allowed to give his/her own homework assignments to suit the students' needs. Homework was used as a tool in the instructional cycle to enable the student to continue the independent practice started during the seatwork activity phase which eventually could lead to individual responsibility for learning.

As practiced, all instructors gave homework almost every session (see 3; Table 6.12). Most of the homework assignments given were taken from the course manual, thus they exhibited clarity and attainability within the given time frame. Only three instructors were observed to give a long and unclear homework assignment (see 5b; Table 6.12). For example, students were assigned to read a chapter on chemical bonds without providing guide questions to work on. Other variable descriptions about the homework are summarised in Table 6.12.

Table 6.12

Variable descriptions about homework

Variable description	Instructors													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
1. instructor checks homework		x			x	x	x	x	x		x	x		8
2. manner of checking homework														
a. random check		x				x	x		x					4
b. through a quiz					x			x						2
c. collecting a paper											x	x		2
d. other (specify boardwork)							x				x			
3. instructor gives homework	x		x	x	x	x	x	x	x	x	x	x	x	12
4. manner of giving homework														
a. written on the chalkboard or transparency	x						x	x						3
b. dictated			x	x	x	x			x	x	x	x	x	9
5. quality of homework														
a. clear or specific	x		x				x	x	x	x	x	x	x	9
b. unclear or broad				x	x	x								3
c. attainable within the given time frame	x		x		x	x	x	x	x	x	x	x	x	11

The giving of homework was done either towards the end of the seatwork activity phase or after a closure or summary had been given. Most instructors dictated the homework orally (see 4b; Table 6.12), while other instructors wrote it on the chalkboard or on a transparency (see 4a; Table 6.12). In addition, four instructors regularly monitored homework assignments through random checking (see 2a; Table 6.12) while two instructors checked on homework assignment by giving a short quiz (see 2b; Table 6.12), and two instructors collected the answer on a paper (see 2c, Table 6.12). This was done to let the students feel the importance of homework and be held accountable for not doing the assignment.

6.3.2.5 Improving basics of classroom management

One of the most basic tasks of a teacher, regardless of the levels of students, is to establish an effective classroom management system, to obtain a smoothly running classroom community, where students are highly involved in worthwhile activities that support their learning. The implementation of the instructional cycle as the teaching scheme in Chem 4 enabled the instructors to develop and try their own classroom management system to support an effective learning environment. The system included the various instructor behaviours presented in Table 6.13. These behaviours could be categorized into three areas of procedures, a) general procedures, b) procedures during instructor-led discussion and seatwork activity, and c) transition management procedures.

6.3.2.6 Implemented classroom management procedures

General procedures included routine activities regularly conducted at the beginning of each class session such as check on attendance, textbooks and homework. It also included the setting of an agreement to implement the university policy on tardiness as well as the behaviour desired and expected of all students during the session. Likewise the beginning and ending of the class on time is also included in this category.

The summary data presented in Table 6.13 showed that only four instructors conducted a check on attendance and tardiness, while five instructors did a spot check for homework completed and textbook ownership. Attendance check was done in various ways such as use of nametag, seat plan and the usual roll call. Tardiness of students reduced after these instructors successfully implemented closing the door after a 15-minute lapse of class time. Other instructors did not mind whether students kept coming late to their class.

Table 6.13

Classroom management behaviours implemented by 13 instructors

Variable description	Instructors													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
1. routine check on														
a. attendance	x	x				x						x		4
b. tardiness	x													4
c. textbook	x	x							x		x	x		5
d. homework		x				x	x		x					4
2. behaviours manifested by the instructor														
a. gives encouragement		x	x		x		x				x			5
b. listens actively		x	x	x	x	x	x	x	x	x	x		x	11
c. controls discipline during transitions between phases					x	x	x	x	x					5
d. controls and maintains student discipline throughout the session						x	x	x	x			x		5
e. addresses the right undisciplined student					x		x		x					3
f. indicates how students should improve their behaviour					x						x			2
g. recognises desired answer and behaviour of student		x			x		x		x		x	x	x	7
h. pays attention to a good working environment		x			x	x	x	x	x		x	x		8
i. starts and ends the class on time			x						x					2

It was agreed during the in-service training that textbooks be made a compulsory requirement for the Chem 4 courses. Textbooks were used during seatwork and homework to answer questions, do problems and readings (see 4c; Table 6.9). The most frequent situation in which textbooks were consulted was at the beginning of a new part of the task, where students searched similar problems to the given task, or read a topic to find an answer to the given questions (see 4b; Table 6.9).

At the beginning of the semester, instructors told students that they must have a textbook because seatwork activities and homework assignments were textbook-based. The students responded to this request although there were three instructors whose majority of students did not have textbooks until the end of the semester. It was learned from the interviews that these instructors did not bother to monitor textbooks and often wrote notes, seatwork questions and problems on the chalkboard (Chapter 7).

Likewise, these instructors admitted they did not like to impose something on the students, particularly the imposition of owning a textbook, due to economic reasons. It could be noted that the cost of the textbook being used in Chem 4 is US$ 8.00 and a semester book loan provided by the University costs US$3.50. Considering that the majority of USC students belong to the middle-income families, the textbook cost was minimal and reasonable. In addition, the required book would also be used for the second semester Chemistry course (Chem 14), the second part of the General Chemistry course for engineering students. Observations had consistently indicated that the instructors' laxity to impose books on students was due to the fact that these instructors did not use the seatwork activities suggested in the course manual, but opted to use their old notes from previous books where they had mastered answers to problems. These instructors did not spend time studying and learning the questions and problems in the new textbook or chose to do what they were most confident doing. Furthermore, some other instructors have a low self-confidence with the subject matter.

A good diagnosis of these reasons enabled the coach to decide on the quality of support needed for the instructors. When the instructor did not read the new book, increased pressure was placed on the instructor. An unconfident instructor or one having low subject mastery required more subject content sessions either with the coach, who conducted team teaching most of the time, or with the content expert colleague.

6.3.2.7 Instructor-led discussion and seatwork activity procedures

Instructor-led discussion and seatwork activity procedures describe classroom management behaviours that the instructor and the students engaged in during the plenary, seatwork and closure phases. The summary data for the 13 instructors presented in Table 6.13 show that most instructors were able to listen actively to student queries (see 2b) and recognise good answers and behaviour of students (see 2g). For example, Instructor B stated, "The class is very responsive today. I appreciate your good behaviour and you are well prepared for this lesson. We've done so many things for this session. Keep up the good work, class!"

Some instructors (B, F, E, & I) were able to manage a class effectively. They were able to control and maintain student discipline throughout the session by addressing the undisciplined student and give immediate feedback when student behaviour was not acceptable. They also verbally set rules on how to improve student behaviour. For example, when the instructor was giving a plenary lecture or a student was made to discuss or present something in the class and the other students kept on talking or left their seats, the instructor used the incident to tell the class quickly that students should refrain from talking and remain seated during the presentation. Another practice by these instructors was to keep quiet, stand still in front of the class and wait for a few seconds until the noise calmed down. The students would quickly recognise from the message of this gesture that their behaviour was unacceptable.

There were also a number of skills exhibited by some instructors while managing a discussion activity creating warmth and a friendly atmosphere to promote security in the class. Only Instructor G was observed to have encouraged students to express their points of view, to have resolved conflicting ideas of students, thus fostering acceptance and openness. In many cases, the discussion was a dialogue between the student and the instructor and rarely among students.

Not all instructors set ground rules for participation during an instructor-led discussion, such as the plenary and closure phases, for example requiring students to raise their hands when the students wanted to answer and to listen carefully when somebody was talking. The absence of such ground rules resulted in students frequently answering in chorus and indulging in conversation most of the time, even when the instructor was giving a mini-lecture.

In the seatwork activity, students were engaged in assignments that built upon previously presented knowledge or skills during mini-lecture. Five instructors exhibited a good management seatwork strategy (Emmer et al., 2000) when a part of the seatwork was illustrated to the class before guided-pair work began (see 5a; Table 6.5). Another procedure practiced by all of the instructors was to circulate around the room and make periodic checks on individual student progress (see 3d; Table 6.9). This procedure worked against students engaging in off-task behaviour and instructor-student interaction was enhanced. It could be noted that once an instructor had established a certain procedure, explicitly or implicitly, students quickly understood such a procedure and eventually a class atmosphere developed appropriate for learning.

6.3.2.8 Transition between phases of the instructional cycle

Transition management procedures as used in this study is an interval between any two phases in the instructional cycle that involves a change of activity focus initiated by the instructor. For example, shifts from the plenary lecture phase to the seatwork activity to closure phase were transitions. In addition, the beginning and ending of sessions and a change from one seatwork assignment to another were transitions.

Managing transitions was the most difficult task that all instructors handled. As observed, the most common transition problems were long delays in starting each phase, a high level of student noise that was carried over into the next phase and the inability of the instructor to control student disruptive behaviours. In other words, there were two sources of transition problems, those that emanated from students and from the instructors themselves. Examples of transition problems that were student-oriented along with the procedures implemented by instructors, which were observed to have worked, are listed in Table 6.14

Table 6.14

Transition problems and some effective procedures undertaken.

Transition problems	Effective procedures undertaken
At the beginning of the session, students talk loudly and this continued even after the instructor had started the mini-lecture.	The instructor started the class with routine procedures (check on attendance, tardiness and homework) to organize the class then quickly used the homework assignment to link past lesson to the present. The use of overhead transparencies to present the lesson caught the attention of students.
Students talk too much just after a seatwork assignment was given but before they began the task. Many students did not start their seatwork activity immediately.	Instructors illustrated and explained a part of the seatwork assignment at the end of the mini-lecture phase and then allowed everyone to continue the task for independent practice. Immediately the instructor walked around the room, checked on textbook and student work. It was noted that the instructor required each student to have a book and a seatwork activity notebook.
Students stop working long before the allocated time for seatwork activity had ended and then engaged in excessive talking, left their seats to socialize or wandered around the room. Some students stayed on their seats but worked on assignments of other courses.	The instructor continuously moved around the room, checked student activity notebooks and gave corrective feedback. Then the student was required to discuss his/her work with a partner or seatmate without leaving the seat. Likewise, the instructor explicitly reprimanded, sometimes confiscated, the paper of students working on assignments for other courses.
In some instances the instructor moved the students from one seatwork assignment into another. Many students did not make the transition but remained working on the preceding assignment.	A warning notice was given a few minutes before terminating the activity to ensure that all students had completed the task before moving on to the next task.

Other causes of transition problems were lack of readiness by the instructor to respond to a problem and the absence of clear procedures about appropriate student behaviour during transitions. Examples to illustrate this are when Instructors A, H, and M waited for a few students who seemed to be slow during transition that resulted in delay for the rest of the class; when Instructors A, D, and C had a long conversation with a few students during the seatwork phase while the rest of the students waited; and when Instructors A, B, C, and E delayed the beginning and ending of the class by returning test papers or collecting homework papers.

6.4 Three Case Studies to Illustrate How Instructors Implemented the Course

As described in the previous section, it was evident that the instructors had varying degrees of success in the implementation of the new Chem 4 course which can be described in three categories. Some instructors were successful, several were moderately successful, while a few instructors seemed to have low success in adopting the instructional cycle model. This section of the results presents three case studies of instructors selected from the sample that represent each category. The presentation of each case starts with a problem associated with the less successful instructors that was identified by the instructors and the students during interviews. The case situations cited are of particular value because they illustrate the difficulties that hinder the smooth implementation of the instructional cycle model. This is then followed by the narratives of cases that are restricted to instructional behaviours exhibited by instructors who were found to be successful in implementing the model.

6.4.1 Case 1: Establishing an orderly classroom atmosphere

A perennial problem in the implementation of the new course was the difficulty of most instructors to control inappropriate noise of students throughout the session. Although no serious student misbehaviours occurred, student noise was annoying and irritating not only to the instructors but also to the students themselves, as revealed during the interviews. This student misbehaviour was one of the causes of losing time during the class and much time was spent waiting for students to be quiet and reprimanding them.

Instructor F was successful in controlling the noise of the students. She managed the class by setting a good start in the semester, spending the first week of the semester organising the class. On the first day of the class, she allowed students to become acquainted with one another in the class and reviewed the university policies regarding absences, tardiness and grading systems. She set ground rules for the class such as non-admittance in class after 15 minutes of being late, that each student should provide and bring his/her own textbook and activity notebook every class meeting and wear a nametag during the class. She also informed students that the class would always start and end with a short prayer and assigned each meeting a student to lead the prayer. She emphasized that good behaviour while the lesson was in progress and active participation were expected of the students every meeting.

On the second day, she introduced the course and explained her policy on make-up tests and the teaching approach to be adapted in the course throughout the semester. She announced to the students;

> Class, we will have a different teaching system to be followed in this course. Each meeting there will be a short lecture, an activity to work on, and a summary of each day's learning be given. During the mini-lecture, I expect you to listen carefully, take notes when necessary and to raise a hand when you want to say something. Homework assignments will be checked regularly either by collecting them on paper, or by giving an unannounced quiz. Thus you need to work on your homework assignments seriously. Seatwork assignments will be provided, but most often questions or problem sets are taken from the textbook, therefore you are required to bring a textbook in class. The first few minutes of the seatwork activity is an individual task after which you will discuss your work with a seatmate and share ideas. No one is allowed to roam around the classroom to socialise during this phase. Everybody is expected to be on task. I'll be going around to check your activity notebook every now and then or you are free to consult me about your task. Consultation should be done one after another. In other words, no group consultation is allowed. After the seatwork, any student will be asked to report on their answers, discussion or to give a summary of what you had just learned. Do you have any questions? (Observation 22/06/00)

A student raised his hand and asked, "Maam, when is the deadline for the book and the activity notebook?" The instructor replied, "Okay, I'll give two weeks to comply with these requirements but next meeting, we will start implementing this procedure (referring to the instructional cycle). So please do your best to have a book and activity notebook with you."

On the third day and onwards, Instructor F began implementing the procedures she set, adding new procedures when needed. This classroom description shows that Instructor F set a good start in order to obtain cooperation from students. The general rules and procedures laid down by the instructor guided the students to successfully engage in all the learning activities. The instructor did not have to waste time restating these procedures every session. With this practice going on, eventually the students became accustomed to these routines and a good learning atmosphere was sustained.

6.4.2 Case 2: Managing student work in progress

Managing student work and learning was one of the difficulties identified by most instructors. These instructors recognized their inadequacy of skills related to meaningful interaction about the subject matter with individual students, the quality and appropriateness of questions asked during the seatwork, and knowledge of student learning difficulties. Instructor G proved to be successful to a certain extent having taught the new Chem 4 course for the third time.

Instructor G started the class with spot-checking student homework which was to make an outline of the rules for naming ionic compounds. While moving around the class, she noted exemplary homework of James, and requested the student to transfer his outline on to a transparency. The classroom discourse ran this way:

Instructor G: Well done class, everybody has done their homework. James will you please present the outline to the class.

James: Who came forward, presented and explained his outline for naming ionic compounds using the overhead projector.

Instructor G: Are there any comments about the outline? Yes, Mario (who was raising his hand).

Mario: (Stood up saying) I think something is missing in the outline, the rule on metal ions with more than one oxidation number is not included.

Instructor G: Anyone who had same idea as Mario (pointing to Sheila, who volunteered to complete the outline). Very good, the outline is now complete. Let us use this outline to name and write the formula of ionic compounds. Open your book on page 158 numbers 5-9. Let us answer the first two numbers in the problem set. Then the other numbers will be your individual work. (Observation, 07/07/00)

After illustrating two examples to the class, the students worked individually. The instructor circulated around the classroom ensuring that everybody began the task. The next round, she looked at students' papers, interacted with them for a few seconds, and continued moving around until everybody's work was checked. Then she said:

> Okay class, stop the individual work, face your seatmate and compare your answers. Find out any differences in your answers, discuss and come up with an agreed answer. Check your answers against the answers displayed on the instructor's table. You are not allowed to see the answers unless you had done the seatwork assignment first.

The above description of teaching practice shows three simple strategies employed by instructor G in attending to the student work. One was the utilization of the homework assignment and student's previous knowledge as a link to the new lesson which could enhance student's responsibility in the learning. The second strategy was to start the seatwork as a whole class activity before any individual work was given. This method resulted in the smooth transition from the plenary lecture mode to independent work. The third strategy was to circulate in the classroom as soon as the individual work has started and check on student progress periodically. This method allowed the instructor to give corrective feedback when needed and keep the students accountable for their own progress.

6.4.3 Case 3: Knowledge of student learning difficulties

An identified area of difficulty for instructors was the inability to spot student-learning difficulties and to use student ideas effectively as a basis for feedback and for the closure of the lesson. For example, most of the instructors just looked or glanced at student papers while circulating in the classroom and failed to take note of errors and difficulties of students. Often they spent more time helping students who requested assistance and this resulted in them being unaware of the progress of other students.

Errors and difficulties should have been the focus of feedback in the closure phase but observers noted that instructors often resorted to providing answers to the seatwork assignment. Likewise, incorrect statements and misconceptions during the discussion also were ignored because the instructor was more concerned with procedural solutions to a problem than with conceptual understanding.

This is indeed a general and pervasive trend in Philippine science and mathematics classrooms (Berg et al., 1998; Bernardo, 1998; Ibe, 1993). The focus is on formulas, procedures, and algorithmic solutions, not on concepts. Lessons are done as a series of isolated little units without connecting different parts of the course through the underlying concepts. However, this problem cannot be solved in one round of implementation of teaching reforms, but requires a long term process of gradual change, of which this project is only a first step.

Instructor K, despite being a neophyte instructor, learned quickly how to identify student errors and provide immediate feedback. Here is an excerpt of instructor K's classroom discourse.

After the instructor gave a mini-lecture on the Aufbau Principle and on the electron distribution in an atom, he gave the whole class seatwork activity.

Instructor K:	Write the electron configuration of potassium.
The class:	Look at the periodic table and find the symbol and atomic number of potassium and begin the task individually.
Instructor K:	(Moved around the classroom twice and looked at student papers. After five minutes he told the students to stop working). I saw two different electron configurations of K_{19} on your papers. (Then he wrote this on the chalkboard) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$ Which of the two-electron configuration is true for the ground state of K_{19}? (He called a student.)
Anna Marie:	The first one (referring to the electron configuration on the chalkboard).
Instructor K:	Encircled the $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ and then asked, What's wrong with the second electron configuration? Yes (pointing to another student).
Joseph:	Electron should not go to 3d.
Instructor K:	Why not? (Calling a student who was raising his hand.)
Jenny:	3d has higher energy than 4s.
Myla:	How do we know that 4s has lower energy than 3d?
Instructor K:	Anyone who can answer that question? (There was a brief silence and no student hands were raised) Okay let us discuss the n + 1 rule.

(Video Transcription, 6/07/00)

This is a typical case where an instructor has to resort to procedures. A student raises the fundamental question "How do we know that 4s has a lower energy than 3d?" But at this point it cannot be explained in terms of deeper concepts; one could give phenomenological explanation and say that K_{19} is very similar to Na_{11} and therefore it was assumed that it has $4s^1$ rather than $3d^1$.

Instructor K, being the youngest and least experienced among the instructors, was strongly committed to learning the new approach of teaching. He tried to create a classroom atmosphere that encouraged the students to interact not only with instructor but also with peers. The interaction above shows that the instructor was quick to spot errors of students' work and used this to start a discussion. The instructor did not give corrective feedback outright, but instead lead questions were given to encourage the students to participate and do the corrections themselves.

6.5 Summary

The purpose of this stage of the study was to examine the Department's implementation of the revised Chem 4 course involving 13 instructors. Following an intensive training on a instructional cycle approach, the focus was on the instructors adapting the three phases in the approach, making sufficient change in their teaching routines and enhancing instructors' knowledge of student learning difficulties.

The intensive training included observation of a skilled instructor plus considerable group discussions reflecting how personal change must be implemented. One strong reaction of participants concerned a perceived problem in monitoring and assessing student work within the time constraints of the seatwork phase. The concept of monitoring individual students was quite unfamiliar and therefore a challenge to the instructors. The usual practice in the large classes faced by these instructors was lecture without any individual interaction. Thus the instructional cycle approach amounted to a culture change.

It is important to note that instructors adapted the instructional cycle with varying degrees of success. The implementation could be classified into three categories such as the successful, the transitory and the least successful group. Three instructors who were successful implemented the instructional cycle approach as intended with clear mini-lectures, well managed student seatwork activities and a closure or summary which included reactions to learning difficulties encountered during the seatwork phase. An average, 30% of the lesson time was spent for lecture, 50% of the lesson time for student seatwork activities and 20% for the closure or summary. This group had a well-managed classroom with rules and procedures about classroom routines set up at the beginning of the semester. It could be noted in the interviews as well as during the training, that these instructors had been very supportive of this change effort because they also believed that college students should be trained more in independent but guided classroom tasks.

The partially successful group of seven instructors, was willing to learn and sometimes took risks while exploring the new teaching approach, holding the conviction that students should develop responsibility for their learning. However, the practiced shortened seatwork time provided in the class did not reinforce more opportunity for doing this. Inconsistency in implementing the routine procedures like checking homework led to students' confusion and misbehaviour. This group of instructors also was beset with learning how to condense a lecture into essentials, guide students to rely on a book and to spot student difficulties and errors. When caught in a difficult situation such as conflict during discussion and student misbehaviour, they tended to resort to the lecture mode instead of acting quickly to attend to the problem.

The least successful instructors were cooperative in the desire to implement the instructional cycle approach but lacked the necessary skills of classroom management, handling student misbehaviour and decision making. Classroom problems were sometimes caused by confusion over content mastery and the inability of instructors to track down student ideas and use these in their interactions.

Overall, all instructors implemented the new course but there is clearly a need for faculty development to focus on issues such as classroom management in transition from one phase to another. The skills of assessing, monitoring and recognising learning difficulties must be prioritised. Instructors must learn the skill of assessing students' learning in order to stimulate class interaction. Continuing to dictate, lecture and give answers prevents students from deciding and being responsible for their own tasks.

The approach taken represents an intermediate stage for the instructors. The instructional cycle approach adopted in this study is an appropriate way to change incrementally from a lecture mode approach to active student learning. The mainly positive results thus far and the opportunity for teachers to learn from each other are encouraging.

CHAPTER 7
STUDENTS' PERCEPTIONS OF THE NEW COURSE

7.0 Overview

This chapter reports on students' perceptions of the new course and their views on the instructional cycle approach as implemented by the instructors. The section starts with the description of the two questionnaires used for collecting data to identify the perceptions of students about their course and perceptions about the learning environment. The second section of the chapter presents the results of the two questionnaires used: the College and University Classroom Environment Inventory (CUCEI) and the Student Perception of the New Course (SPNC). The results were analysed using simple statistical description of the data. Identification of recurrent themes and salient comments related to the new Chem 4 course were revealed in interviews and are integrated into the analysis. The last section is a summary of the chapter.

7.1 The Questionnaires

Two sets of questionnaires were administered to all Chem 4 students at different times toward the end of the semester. The first questionnaire, College and University Classroom Environment Inventory (CUCEI) developed by Fraser, Treagust, Williamson and Tobin (1986), was administered by the researcher to 630 students on the second last week of the class. The CUCEI was designed to gather students' perceptions of the psychosocial characteristics of the learning environments. The field-testing of this instrument to upper secondary and university classrooms in USA, Australia and in Canada (Clarke, 1990; Fraser et al., 1986; Nair & Fisher, 2001) confirmed its reliability and validity in these countries/cultures. There are seven scales in this instrument: personalisation, involvement, student cohesiveness, satisfaction, task orientation, innovation and individualization. Each item in each of the scales is responded to according to the alternatives of Strongly Agree (SA), Agree (A), Disagree (DA), and Strongly Disagree (DA). The responses are scored as 5, 4, 2, and 1, respectively. The negative items are scored in reverse as in the original version. Table 7.1 shows the description of each scale and a sample item of scales. The inventory has both the actual and preferred forms. Only the actual form of this instrument was used in this study.

Table 7.1

Scale description and sample item (adopted from Fraser et al., (1986)

Scale Name	Description of Scale	Sample Item
Personalization	Emphasis on opportunities for individual students to interact with the instructor and on concern for students' welfare	The instructor goes out of his/her way to help students. (+)
Task Orientation	Extent to which class activities are clear and well organized	Students know exactly what has to be done in class. (+)
Student Cohesiveness	Extent to which students know, help and are friendly to each other	Students in this class get to know each other very well. (+)
Involvement	Extent to which students participate actively in class discussions and activities	The instructor dominates the discussion. (-)
Satisfaction	Extent of enjoyment of classes	Classes are boring. (-)
Innovation	Extent to which the instructor plans new unusual class activities, teaching techniques, and assignments	New and different ways of teaching are seldom used in this class. (-)
Individualization	Extent to which students are allowed to make decisions and are treated differentially according to ability, interest, or rate of working	Students are allowed to choose activities and how they will work. (+)

There was no intention to undertake a rigorous validation process for the CUCEI with the Philippine students. Rather, the instrument was used to investigate the perceptions of the students on the kind of classroom atmosphere created during the implementation of the new Chem 4 course.

The researcher administered the Student Perception of the New Course (SPNC) questionnaire during the last week of classes to 624 students. Six students who answered the CUCEI were absent during the administration of the second questionnaire. This questionnaire, which was developed by the researcher, asked for student perceptions of their class and factual questions with regard to the teaching of the new Chem 4 course. Each of the items in the SPNC is responded to by the following alternatives: Every Class Session, Twice A Week, Once A Week, Once A Month, Once A Semester, and Never and scores for the responses are 1, 2, 3, 4, 5 and

6, respectively. The scoring of the negative items was reversed. Two open-ended questions also were included in this questionnaire to determine other comments of the students about their class and to discover students' views for improving the course. A sample of SPNC questionnaire is attached in Appendix D. The alpha Cronbach reliability coefficient for the questionnaire was 0.87. Data obtained from SPNC questionnaire were analysed using simple descriptive statistics.

7.2 Students' Perceptions on the Implementation of the New Chem 4 Course Based on Data from the CUCEI

Student evaluations of college-level courses are valuable tools for assessing and improving classroom teaching. In fact, nearly 80% of post-secondary institutions have used students' perceptions of courses and their instructors to obtain a numerical evaluation of instruction (Trout, 1997). In this study, students' perceptions were used to investigate the effectiveness of the instructional cycle teaching approach to improve the teaching and learning of Chem 4.

The actual form of the CUCEI was administered to determine the actual experiences of students in the new Chem 4. The mean of each scale was used as the basis for describing classroom experiences as perceived by the students and the relevant descriptive statistics associated with each scale are shown in Table 7.2. Mean scores greater than 3.00 indicate mildly positive environment; the higher the means the better the perceived learning environment. Scores less than 3.00 indicate that personalisation, task orientation, student cohesiveness, involvement, satisfaction, individualization, and innovation scales happened less in Chem 4 class; the lower the mean score shows the absence of these factors as perceived by students. The Cronbach alpha measure of reliability was calculated for each scale, using the student as the unit of analysis. The results in Table 7.2 show Cronbach alpha values ranged from 0.31 to 0.82. The values for the original actual form of the CUCEI are 0.53 to 0.83 (Fraser et al., 1986) and Nunally (1967) set a value of 6.0 as acceptable reliability for making judgments about the responses. Caution is then needed when making judgments about scale with a Cronbach alpha less than 0.60.

Table 7.2

Descriptive statistics for each scale

CUCEI Scale	Mean	Standard Deviation	Alpha Reliability
Personalization	3.73	0.67	0.72
Task Orientation	3.61	0.59	0.63
Student Cohesiveness	3.44	0.54	0.75
Involvement	3.31	0.54	0.47
Satisfaction	3.19	0.52	0.82
Individualization	2.94	0.45	0.31
Innovation	2.82	0.50	0.36

A number of issues emerge from this analysis: First with regards to personalisation, students tended to agree that the course provided them with opportunities to interact with the instructors who were perceived by the students as reachable and available to help them with their difficulties (mean = 3.73; sd = 0.67). These findings complemented the comments of students from the last two questions in the SPNC questionnaire.

> I like now our instructor because she made complicated lessons easy to understand and ensures that we understand our lessons. (Student # 2 of Instructor F; 10/00)

> This class is very responsive and very close to the instructor because she is very approachable. (Student # 11 of Instructor G; 10/00)

Second, with regards to task orientation, students affirmed that tasks were given in the class and that the instructor emphasized that certain amounts of work must be done in class or through homework assignments (mean =3.61; sd = 0.59). This perception is consistent with the result presented in Table 6.4, which indicates that all the instructors had seatwork activities, only that the time used for seatwork activity varied for each instructor. The data for the open-ended question in the SPNC questionnaire also echoed this:

> Activity every after the instructor's discussion is a nice way for the students to grasp knowledge about a certain topic. (Student # 26 of Instructor H; 10/00)

> We are always doing activities in this class, sometimes it is clear but other times activities are vague. (Student # 36 and similar comments from 24, 28, 29 of Instructors B, C, E, and K, respectively; 10/00)

Third, with regards to student cohesiveness, students perceived that the class gave them the opportunity to get to know their peers as indicated by a mean score of 3.44 (sd = 0.54) and the comments from the SPNC questionnaire:

> My classmates help me to understand things about chemistry that I did not understand before. My group-mates are friendly and cooperative. (Students # 20, 22 of Instructor L; 10/00)

> This is a kind of class wherein students are united as one. A very good combination of students. (Students # 12, 35 of Instructors G and H, respectively; 10/00))

However, a substantial number of students perceived that cohesiveness was not extensively evident in their classes. This observation is confirmed by the researcher's journal record that the group activities were limited to working with a seatmate and seldom done in small groups of five-six students. Another reason for less cohesion in the class was that some instructors implemented a permanent grouping throughout the semester, thus reducing students' opportunities of working with other students in class. Students expressed this finding in the SPNC questionnaire as:

> I don't like much the members of my group because they are not cooperative during discussion. I hope I could be with other students, too. I suggest that next time the instructor should not make the groupings permanent. (Students # 45, 17, 13 of Instructors E, I, and K respectively; 10/00)

> I only know my seatmate because we always work together during seatwork and homework. (Students of Instructors A, B and J)

Fourth, with regards to involvement, the mean score of 3.31 (sd = 0.54) indicated students' active involvement in their Chem 4 class was evident. Involvement ranged from listening to the instructor and reports of classmates, working on the given task during the seatwork and discussing a given question or a problem with peers. Comments of students from the SPNC questionnaire supported this finding:

> This class is great! We all got to have the chance of talking and giving out our ideas that would help the other students who don't really understand. (Students # 15, 3, 13, 21 of Instructors C, F, G, and I, respectively; 10/00)

> This class is very wonderful because we are given a chance to speak or give our own opinion towards the lesson where we share our brilliant ideas. (Students # 8, 1 of Instructors G and H, respectively; 10/00)

Fifth, with regards to satisfaction, students expressed satisfaction about the new Chem 4 class (mean = 3.19; sd = 0.52). Perceiving that the class was interesting and enjoyable as two students commented in the SPNC questionnaire:

> I like this type of learning — lots of interaction with the instructor and peers. (Students # 24, 38 of Instructor G)

On the other hand, many students were dissatisfied with the poor classroom management of some of their instructors. Some of their comments were:

> I like the system of teaching but during seatwork and other activities students are noisy and the instructor just ignores them. (Most students of Instructors A, B, C, D, H, J, K, L and M; 10/00)

> Chem 4 class is just a wonderful class but it has something to improve not in lecture but in implementing rules because it was really a noisy class. (Most students of Instructors C, H, J, K and L; 10/00)

Sixth, with regards to individualization and innovation, the low means of the individualization (mean = 2.94; sd = 0.45) and innovation (mean = 2.82; sd = 0.50) scales show that students perceived that the method of teaching Chem 4 was the same throughout the semester and that activities were determined and decided by the instructor. This finding supports the consistent implementation of the instructional cycle to teach Chem 4 and that instructors followed the course material provided to them. Video-taped records did not indicate innovations to the instructional cycle teaching approach made by any of the instructors. Even though students perceived a uniform teaching approach in Chem 4, many recognized the new approach was innovative compared to their other courses. A few students gave their comments as:

> What I like in our Chem 4 was that a boring lecture was shortened and the teacher uses real life situations to explain a topic. (Students # 25, 20 of Instructors C and D respectively; 10/00)

> We need to view more videos about the application of chemistry and have some fun like in a role-play or demonstrations. (Students # 11, 25 of Instructors B and F; 10/00)

7.2.1 CUCEI across instructors

This study also examined the extent to which each instructor implemented the new course. The CUCEI data in Table 7.3 show the mean scores for each scale for the perception of each class about the learning environment created by each instructor.

The mean scores for each of the six scales yielded trends in the type of learning environment for each instructor. On the personalization scale, students of Instructor G (mean = 4.26) and H (mean = 4.04) perceived a positive classroom atmosphere characterized by better opportunities for interaction with instructors and the instructors' concern for students' behaviours in class. In addition, students perceived that 10 instructors (A, B, C, D, E, F, I, J, K and M) were moderately friendly, considerate to their feelings and were willing to help any student in class as indicated by the mean scores which ranged from 3.27 to 3.97. This range of mean scores could also illustrate that the 10 instructors circulated around the class to monitor students' performance, interacted with them, and assisted them in their seatwork assignments.

On the other hand, students of Instructor L disagreed that their classroom atmosphere was characterized by personalization as indicated by the lower mean score of 2.95.

Table 7.3

Mean scales of the College and University Classroom Environment Inventory for each instructors' class

Instructor	Mean for each scale						
	Persona-lization	Task Orienta-tion	Student Cohesive-ness	Involve-ment	Satis-faction	Individua lization	Innova-tion
A	3.27	3.25	3.26	2.92	2.86	2.73	2.44
B	3.84	3.52	3.39	3.33	3.24	3.01	2.99
C	3.92	3.77	3.39	3.48	3.26	3.09	3.03
D	3.82	3.59	3.45	3.21	3.23	3.08	2.95
E	3.32	3.25	3.38	3.03	3.10	2.88	2.82
F	3.96	3.95	3.46	3.53	3.43	3.01	2.89
G	4.26	4.19	3.92	3.88	3.47	3.20	2.95
H	4.04	3.72	3.47	3.43	3.13	2.92	2.93
I	3.96	3.94	3.67	3.36	3.43	2.92	2.85
J	3.36	3.49	3.43	3.11	3.23	2.99	2.79
K	3.97	3.53	3.43	3.24	2.99	2.97	2.54
L	2.95	2.96	3.03	3.25	2.71	2.64	2.88
M	3.78	3.68	3.57	3.25	3.26	2.84	2.76

An inconsistency emerges again when compared to the video records of teaching. Videotapes indicated that Instructors A, D, H, and M did not circulate around the class and ensured that all students worked immediately (see 3b; Table 6.9) and were consistently on task (see 3c; Table 6.9). Scrutinizing the researcher's classroom observations, the data revealed that Instructors A, J and L had most of the time stayed in front of the class, had a noisy classroom atmosphere and many times did not reprimand students' misbehaviour. In one of the small group sessions, Instructor L commented:

> It is difficult to control and monitor 50 students within 20 minutes when they are already at work and then bring them back to listen to the teacher after giving some freedom to be on their own. (Small group session; 26/06/00)

The statement above could indicate either an admission of a lack of classroom management skills, having inadequate skill on assessing students' performance formatively or an adjustment to the new teaching approach.

The high mean score in task orientation in Instructor's G class (4.19) indicated that class activities were evidently clear and well organized whereas the classroom environment of the other 12 instructors (A, B, C, D, E, F, H, I, J, K, and M) were perceived by the students as being mildly task-oriented. These instructors were able to get a certain amount of work done, organized the class, and the tasks were clear and planned (mean scores ranged from 3.25-3.95). Students of Instructor L tended to slightly disagree that their classes were task-oriented (mean = 2.96). These findings are inconsistent with the video-records of teaching because video-tapes show that all instructors gave tasks during the seatwork activity phase (see 1; Table 6.9) and the range of time used for the seatwork phase was 10-66% of the actual class time (Table 6.4). In fact, a videotape record of Instructor L teaching showed two rounds of seatwork activities (see 1, Table 6.9). Going through with the classroom observations, Instructors B, D and E had seatwork assignments which were collected and marked and their students perceived this action as a quiz rather than a guided seatwork activity.

Student cohesiveness was moderately evident in classes of all 13 instructors as shown by the mean scores ranging from 3.03 to 3.92. This result indicates that students perceived that they had opportunities to know and help each other, particularly during seatwork activities where working with pairs or in small groups was recommended in the course manual.

Students of the 12 instructors (B, C, D, E, F, G, H, I J, K, L, and M) that claimed they had participated actively and attentively in class discussions and activities as indicated by the range of mean scores from 3.03 to 3.88 on the involvement scale. However, this claim was less evident in Instructor's A class because her students stated that they were less active and attentive in their Chem 4 class discussions and activities (mean = 2.92). It must be noted that video records of Instructor's A teaching did not manifest behaviours such as listening actively (see 2a; Table 6.13), giving encouragement (see 2b; Table 6.13), controlling discipline during transitions between phases (see 2c; Table 6.13), maintaining student discipline throughout the session (see 2d; Table 6.13), and paying attention to a good working environment (see 2h; Table 6.13). Likewise, problems on classroom management were frequently observed in Instructor A's class.

The mean scores of the scales on innovation ranged from 2.44 to 3.03. These data showed that new and unusual class activities, teaching techniques and seatwork assignments happened less frequently in the classes of almost all instructors. Even the mean score of 3.03 in Instructor C's class could indicate that the students rarely experienced varied teaching approaches in their Chem 4 class. The situation is similar in the individualization with mean scores ranging from 2.64 to 3.20. The slightly positive learning environment, in terms of individualization, occurred in Instructors B, C, D, F, and G classes as indicated by class means of 3.01, 3.09, 3.08, 3.06, and 3.20, respectively. The learning environments in classes of Instructors A, B, E, H, I, J, K, L, and M did not provide opportunity for students to choose or decide on the activities they wanted to work on as indicated by the lower mean scores ranging from 2.64 to 2.99.

The findings on innovation and individualization are expected for reasons that the emphasis of the new Chem 4 course was to apply the three phases of the instructional cycle approach; thus, the instructors limited themselves to the use of the instructional cycle instead of being innovative. In addition, seatwork and homework assignments were prescribed and determined by the instructor, that is why students perceived that they did not have any voice to choose their own activities at their own pace. The CUCEI scales about self-pacing and influence of students on the activities is not appropriate in this study as the first step in the course innovation was largely teacher directed even though it was more student-centred. This aspect of the course could account for the low reliability values of the individualization and innovation scales.

Overall, the scales of CUCEI could be used to postulate that the majority of the instructors implemented the instructional cycle as the scheme for teaching Chem 4 course; however, this generalisation must be treated with caution for two reasons. First, the instrument did not undergo a rigorous process of validation within the Philippine context. Second, is that the emerging inconsistencies of some of the results indicate that students may have interpreted the statements in the questionnaire differently as originally intended. This situation is common in the Philippines and is pointed out as weakness of using questionnaires in this culture (Berg, 2002). Other studies had also pointed out differences of culture that could affect the generalization obtained from questionnaires (Nair, 1999; Lee, 2001).

7.3 Students' Perceptions on the Implementation of the New Chem 4 Course Based on Data From the SPNC

The second instrument is a list of teaching and learning activities expected to happen in the new Chem 4 course. Students ticked those activities according to the frequency of occurrence. Items 1-44 deal with basic components of teaching the new Chem 4 course while item 45 (I learn some practical applications of Chemistry in my daily life) is a general measure of effective chemistry teaching. Lower values of scores on each item reflect frequent occurrences of the activity, while higher values reflect rare occurrences. To facilitate the interpretation of the data obtained, a range of mean scores was established and used as a basis to describe occurrences of teaching and learning activities for the new course. The corresponding description of occurrence is given in Table 7.4. It should also be noted that terms such as short lecture indicate that less than or equal to 50% of the actual time is teacher talk, while long lecture means that equal to or greater than 90% of the actual time is teacher talk. A small group as used in this study means that there are five to six members in a group.

Table 7.4

Range of mean scores and their description of occurrence on the Student Perception of the New Course questionnaire

Range of mean score	Description
1.0-1.44	Every class session
1.45-2.44	Twice a week for MWF classes
2.45-3.44	Once a week
3.45-4.44	Once a month
4.45-5.44	Once a semester
5.45-6.00	Never

A list of 45 teaching and learning activities included in the SPNC questionnaire, in declining order of occurrences, is presented in Table 7.5. The means of each item were used to estimate the extent to which instructors implemented the new course. According to the students, the activity most frequently occurring in their class was the bringing of the activity notebook (mean = 1.41). All instructors required activity notebooks so that students could record their answers during seatwork and homework assignments. Sometimes the activity notebooks were collected at the end of the session for checking answers or monitoring difficulties of students about certain topics. Since the students came from a grade conscious school environment where, in some private schools points are given for everything, failure to bring their activity notebook would mean missing a score.

Table 7.5

Mean occurrence of teaching and learning activities for the new course (N=624)

Teaching and learning activities.	Mean
I bring my activity notebook for this class.	1.41
Use the textbook in class.	1.57
Teacher gives a seatwork or activity.	1.57
Teacher checks whether my classmates are working on the seatwork.	1.61
Teacher checks whether I am doing my seatwork.	1.71
The teacher makes sure everybody is quiet or settles before he/she starts talking.	1.86
The teacher calls the attention of inattentive students.	1.86
Teacher discusses part or all of our homework.	1.87
Teacher helps me when I have trouble with the seatwork.	1.92
I come to class with textbook.	1.98
I cannot hear the teacher when he/she is talking/discussing in class.	2.01
Teacher gives comment about my seatwork.	2.09
The teacher is consistent in implementing the rules set in this class.	2.13
Teacher gives homework for the next session.	2.16
Homework is clear so I know what to do.	2.20
Teacher gives a long lecture ($\geq$ 90% of the session is teacher talk).	2.28
Teacher moves about the class to talk to me or my seatmate or other classmates.	2.32
I learn some practical applications of chemistry in my daily life.	2.39
I hold discussion with a seatmate.	2.44
Teacher gives a summary of the lesson.	2.45
I solve textbook problems with my seatmate.	2.46
Teacher checks whether my homework is correct.	2.47
I do my homework by myself.	2.47
Teacher checks whether I have done my homework.	2.48
Teacher checks several classmates on whether they have done their homework	2.50
I learn from other students in this class.	2.51
Teacher reads seatwork of my classmates and reacts.	2.58
The teacher continues talking even if my classmates are noisy.	2.66
During a quiz or test some/many of my classmates are copying/cheating.	2.70
I chat with my seatmates while a student is reciting or answering.	2.78
I chat with my seatmate while the teacher is talking or discussing.	2.81
I solve blackboard/ textbook problems by myself.	2.86
Teacher does a demonstration.	3.09
Teacher gives grade or score on our homework.	3.11
Teacher gives feedback about a quiz.	3.29
Teacher gives grade or score on our seatwork.	3.30
Teacher gives a short lecture ($\leq$ 50 % of the session is teacher talk).	3.31
Teacher gives a quiz.	3.31
I read topics in the textbook or other references without being told by the teacher.	3.72
We hold a small group discussion (5-6 members in a group).	3.93
View a CD or video.	4.22
I come late.	4.32
I wear my nametag.	4.41
I come to class without textbook.	4.53
I am absent in this class.	5.18

Eighteen of these activities were perceived by the students to happen twice a week in their classes (means from 1.57-2.44), while the students experienced 19 of these activities once a week (means from 2.45-3.44). The five activities that occurred the least (once a month) were: reading a textbook and other references without being told by the instructor (mean = 3.72), holding a small group discussion (mean = 3.93), viewing a CD or video (mean = 4.22), coming too late (mean = 4.32), and wearing a nametag (mean = 4.41). The two activities that happened only once in a semester was coming to class without textbook (mean = 4.53) and being absent from the class (mean = 5.18).

Classroom observations corroborated that activities such as giving and monitoring seatwork assignment, the instructor moving around the class, giving homework assignments, instructor interacting with students either individually or in small groups, students bringing textbooks and activity notebooks, instructor reprimanding inattentive students occurred frequently in all classes. Instructors checking on seatwork assignment was also done every time that a seatwork activity was conducted but the extent of checking varied. The majority of the instructors just looked at students work while circulating around the class without initiating interaction with individual students. Few instructors tried to check students' work and at the same time interacted with individual students or in small groups; however, the associate supervisor, during his observation on the lesson about Lewis structures and electron exchange, noted that Instructor G did attempt to do this. His report stated that:

> Seatwork and monitoring went well, Instructor G constantly moves around, checks and interacts. She did pick up a major error when a student drew a Lewis structure on the chalkboard and drew all electrons instead of the valence electrons only. The instructor reacted quite well. (Classroom observation; 27/04/00)

In many cases, most of the instructors interacted with students as a whole class even during the seatwork phase. This practice disrupted students' attention while concentrating on their task that could result in students slowing down or even stopping on their task. Individual or small group checking of the tasks was overly emphasized during the coaching sessions; however, instructors seemed to be unskilled in monitoring and assessing formatively students' performance because they were not used to doing this in the lecture-mode of teaching.

Another activity noted by students as happening weekly, and which was confirmed by classroom observations, was the instructors checking the homework assignments. The observer noted that the majority of the instructors conducted a spot-checking of the homework as a way to persuade all students to work on the homework assignments while few other instructors gave a quiz to put pressure on doing the homework tasks. Only one instructor (Instructor C) announced repeatedly to her class that working on homework assignments remained an option for the students because she would not check them anyway. This seemed to be an unusual action of an experienced instructor and could be construed as a way of evading the burden of checking many papers. However, during a small group session with instructors, Instructor C explained her action when she said:

> I don't like the idea that students just work on their homework because I will either check or grade them. I wanted my students to realize that doing homework is their responsibility and I should provide that opportunity for them. (Small group session; 30/06/00)

Instructor I disagreed with Instructor C's idea. The former insisted that

> the responsibility of one's own learning follows when students are provided with adequate guidance while in class. But since our class is large we cannot monitor them all at one time and so I think doing homework is an extension of seatwork. Therefore both seatwork and homework assignments must be monitored and checked frequently. (Small group session; 30/06/00)

Both instructors I and C had their own beliefs and each had exhibited some ineffective teaching behaviours observed by the researcher that had become established over many years. It is particularly difficult to alter such behaviours and beliefs. What is important here is that instructors were given the opportunity to identify their weaknesses, become aware of their ineffective teaching behaviours and considered effort to work toward change. Effecting change is perhaps the most difficult part of improving teaching; however, persistence of effort, practice, feedback, adjustment and more practice are critical elements for self-improvement (Druger, 1997).

An opposing trend is noted between the claims of students and the observer about the long and short lecture. Students claimed that long lecture occurred twice a week (mean = 2.28) and a short lecture happened once a week (mean = 3.31) while the classroom observations diary of events indicated that 12 instructors frequently implemented long lectures during the first month of the semester and short lecture became gradually evident thereafter. A long lecture, as described in the questionnaire, is when the instructor talked for about or more than 90% of the actual class session while short lecture indicates that about or less than 50% of the actual class session is dominated by teacher talk. Cross-checking the data obtained from videotapes clarified the contradiction. Videotape analysis related to time logs, which are also presented in Table 6.4 indicated that when time spent for plenary and closure phases are added together, only Instructors F and G gave a short lecture. Since classroom observations revealed that plenary and closure or summary phases were instructor-dominated activities, the students are probably correct in their perception.

7.3.1 Students' perceptions on the instructional cycle model

The activities related to the implementation of the three phases in the instructional cycle model are presented in Table 7.6. These items were selected from the 45-item SPNC questionnaire shown in Table 7.5. From the analysis, students perceived that the three phases in the instructional cycle were implemented in their Chem 4 class. The instructors implemented a mini-lecture at least once a week (mean = 3.31) and used the class time for long lectures twice a week (mean = 2.28). A chemical demonstration also was used almost every week in their classes. This finding complements the finding from videotapes that short demonstrations, though rarely done, were used as a supplement to mini-lectures (see 4a; Table 6.5).

Table 7.6
Mean occurrence of teaching and learning activities related to the instructional cycle model

Activities Related to the Three Phases in the Instructional cycle Model	Mean
A. Plenary Phase	
Teacher gives a long lecture ($\geq$ 90% of the session is teacher talk).	2.28
Teacher does a demonstration	3.09
Teacher gives a short lecture ($\leq$ 50% of the session is teacher talk	3.31
B. Seatwork Phase	
Teacher gives a seatwork or activity.	1.58
Teacher checks whether my classmates are working on the seatwork	1.62
Teacher checks whether I am doing my seatwork.	1.71
Teacher helps me when I have trouble with the seatwork.	1.92
Teacher gives comment about my seatwork.	2.09
Teacher moves about the class to talk to me or my seatmate or other classmates.	2.33
I hold discussion with a seatmate.	2.44
I solve blackboard/ textbook problems by myself.	2.86
Teacher gives grade or score on our seatwork.	3.29
Teacher gives a quiz.	3.32
We hold a small group discussion (5-6 members in a group).	3.93
View a CD or video.	4.23
C. Closure or Summary	
Teacher gives a summary of the lesson.	2.46
Teacher reads seatwork of my classmates and reacts.	2.58
Teacher gives feedback about a quiz	3.29
D. Students' learning from the course	
I learn some practical applications of chemistry in my daily life.	2.39
I learn from other students in this class.	2.51

In the seatwork phase, six instructor activities were rated by the students as occurring twice a week in their chemistry class (means = 1.58-2.33). Instructors marking seatwork and giving a quiz occurred once a week (means = 3.29-3.32). Students claimed that discussion with a seatmate (mean = 2.44) was the most popular seatwork activity they experienced followed by individual solving of problems either from the textbook or provided by the instructor on the chalkboard (mean = 2.86). The use of small group discussion was seldom done (mean = 3.93) and use of CD or videos was rarely implemented as seatwork activity (mean = 4.23) even though that it was made known to the instructors that audio-visual materials for General Chemistry were available in the Department.

Three teacher activities related to the closure and summary phase were implemented in Chem 4 classes at least once a week. These teacher activities included giving a summary of a lesson (mean = 2.46), reading and reacting to seatwork assignments (mean = 2.58) and giving feedback about the quiz (mean = 3.29). The time spent for the closure or summary phase was short. This claim, supported by Table 6.4, also confirmed that the time used for the closure or summary phase was between 1-27 minutes, and observation records confirmed that often instructors utilized closure or summary phase to provide answers to the seatwork assignment questions, thus making it a teacher talk-dominated-phase again.

7.3.2 Students' perceptions on the classroom management

The activities listed in Table 7.7 determine the extent to which the instructor managed the class while implementing the instructional cycle teaching approach. Classroom management as described in this study consisted of implementing routines, efficient use of textbook, monitoring attendance and tardiness, efficient use of homework assignment and seamless transition between phases in the instructional cycle. These aspects are discussed in the preceding sections.

7.3.2.1 Implemented classroom routine practices

Routine practices included the bringing of activity notebook, textbook and wearing of nametag. According to the students, the most implemented routine practice was the bringing of activity notebook (mean = 1.41). Students acknowledged that they brought textbook to class twice a week (mean = 1.99) and came to class without textbook at least once a week (mean = 2.47). The least implemented among the routine practices was the wearing of nametag (mean = 4.41). Journal records also confirmed that few instructors implemented the use of nametag as a method to facilitate the monitoring of tardiness and attendance of students, without using up much of the class time. Nametags also were used to identify students during discussion. Other instructors retained the use of a seat plan. The wearing of nametags was done only at the beginning of the semester when the instructors were becoming familiar with the students' names.

7.3.2.2 Use of textbook

Students indicated that textbook was used in class two times per week (mean = 1.58) particularly, in solving problems or answering questions either done with a seatmate (mean = 2.40) or once a week by the student himself or herself (mean = 2.86). Students also claimed that they voluntarily read the textbook and other references at least once a month (mean = 3.72). However, these mean values indicate that textbooks were not used extensively in the class. Classroom observations also revealed that the use of textbook was limited to answering end-of-chapter questions, reading silently a topic from textbook and students consulting textbooks while solving standard problems. All instructors required each student to have textbook and be brought them in class but two of these instructors (Instructors C and D) did not consistently impose the bringing of the textbook in class. As a result, these instructors wrote definitions and seatwork activity questions on the chalkboard while students were making a noise. The time for writing notes or questions on the chalkboard could have been spent moving around the class, monitor students so that everybody could be on task and misbehaviour could be prevented.

7.3.2.3 Monitoring attendance and tardiness

In the pre-project study (Chapter 4), many students were coming late to class and a substantial number also were absent. With the new course, students were rarely absent (mean = 5.18) and seldom came to class late (mean = 4.32). The improvement of attendance and the decline of tardiness were caused by the instructors' monitoring the students and implementing the University's policy on tardiness and absences. The instructors admitted that they tended to check students' attendance and tardiness regularly more than they used to do.

Table 7.7
Mean occurrence of teaching and learning activities related to classroom management

Activities related to classroom management	Mean
A. Implementing routines	
I bring my activity notebook for this class.	1.41
I come to class with textbook.	1.99
I come to class without textbook.	2.47
I wear my nametag.	4.41
B. Use of textbook	
Use the textbook in class.	1.58
I solve textbook problems with my seatmate.	2.40
I solve blackboard/ textbook problems by myself.	2.86
I read topics in the textbook or other references without being told by the teacher.	3.72
C. Monitoring attendance and tardiness	
I come late.	4.32
I am absent in this class.	5.18
D. Efficient monitoring and use of homework assignments	
Teacher discusses part or all of our homework.	1.88
Teacher gives homework for the next lesson.	2.16
Homework is clear so I know what to do.	2.21
Teacher checks whether my homework is correct.	2.47
I do my homework by myself.	2.48
Teacher checks whether I have done my homework.	2.48
Teacher checks several classmates on whether they have done their homework	2.50
Teacher gives grade or score on our homework.	3.11
E. Seamless transition between phases	
The teacher makes sure everybody is quiet or settled before he/she starts talking.	1.87
The teacher calls the attention of inattentive students.	1.87
The teacher is consistent in implementing the rules set in this class.	2.14
F. Unwelcome activities	
I cannot hear the teacher when he/she is talking/discussing in class.	2.02
The teacher continues talking even if my classmates are noisy.	2.67
During a quiz or test some/many of my classmates are copying/cheating.	2.70
I chat with my seatmates while a student is reciting or answering.	2.78
I chat with my seatmate while the teacher is talking or discussing.	2.81

7.3.2.4 Monitoring and use of homework assignment

Homework assignments were included in the new Chem 4 course as an independent practice of students about the knowledge and skills learned during the in-class session. The data in the analysis indicate that giving of homework assignments and discussing about the homework assignments occurred twice a week rather than every class session. In fact students claimed that checking of homework was done only once a week through a visual check (means = 2.48-2.50), through checking on individual student's homework (mean = 2.47), and by marking homework assignments (mean =3.11). These findings corroborated with a class observation where Instructor C repeatedly announced a homework assignment to her students but she did not check it and so the students were left to decide on whether or not to work on the homework. Instructor C had expressed during small group discussion her belief that giving homework assignments during the weekend is an unfair practice by the teacher because students should be free from school tasks on weekends. In addition, students also perceived that homework assignments were often clear and well directed (mean = 2.21) so they worked on the task independently for at least once a week (mean = 2.48).

7.3.2.5 Making seamless transition between phases

Students perceived that instructors ensured that everybody was quiet and settled before anybody talked and inattentive students were reprimanded (mean = 1.87). However, video and observation records indicated that managing transitions from plenary lecture to seatwork activity and vice-versa were the weaknesses of many of the instructors (see 2c; Table 6.13). This difficulty could be caused by irregular implementation of the rules set in the class, at least as experienced by the students. Most instructors did not provide enough wait-time for students to settle before shifting to another activity. This observation was complemented by the unwelcome activities exhibited by the instructors as perceived by the students. Unwelcome activities of instructors were inconsistent implementation of rules set in class (mean = 2.14), low-modulated voice (mean = 2.02), talking even when students were noisy (mean = 2.67), never checking students who were conversing with each other while someone was discussing or reporting (means = 2.71 and 2.81).

7.4 Differences Among the Instructors

The means for each item in the SPNC questionnaire were calculated for each class and these are presented in two tables. Table 7.8 shows the mean occurrence of teaching and learning activities in the new course for the eight classes taught on Mondays, Wednesdays and Fridays (MWF) while Table 7.9 shows means for six classes taught on Tuesdays and Thursdays (TTh).

Table 7.8

Mean occurrence of teaching and learning activities per instructor (MWF Group)

Description of Activities	Item Means Per Instructor							
	C	D	E	G	H	K	L	M
1. I am absent in this class.	2.56	2.23	1.66	1.87	2.18	1.24	2.03	2.15
2. I come late.	3.14	2.53	4.94	2.92	2.78	3.54	2.15	2.13
3. I wear my nametag.	5.84	5.81	5.40	4.58	5.47	5.80	1.21	4.03
4. I bring my activity notebook for this class.	1.56	1.12	2.49	1.16	1.06	1.80	1.03	1.23
5. I come to class with textbook.	2.42	3.23	3.32	1.82	1.53	1.52	1.85	1.98
6. I come to class without textbook.	3.14	3.37	4.13	2.45	2.53	2.12	2.15	2.88
7. Teacher gives homework for the next session.	1.84	2.79	2.60	1.95	2.10	2.10	1.21	1.90
8. Homework is clear so I know what to do.	2.09	2.42	3.51	1.58	2.17	1.80	4.03	1.93
9. I do my homework by myself.	3.09	2.19	2.87	2.13	2.53	2.46	3.15	2.48
10. Teacher checks whether I have done my homework.	3.95	2.79	3.02	2.03	1.80	2.24	2.12	2.80
11. Teacher checks whether my homework is correct.	4.19	2.74	2.70	2.08	1.94	2.24	2.91	2.80
12. Teacher checks several classmates on whether they have done their homework	4.00	2.42	2.60	2.11	1.98	2.46	2.44	2.42
13. Teacher gives grade or score on our homework.	4.84	3.23	2.60	2.26	2.43	2.62	3.41	3.73
14. Teacher discusses part or all of our homework.	2.14	2.00	2.51	1.55	1.59	1.72	1.53	1.75
15. Teacher gives a long lecture ($\geq$ 90% of the session is teacher talk).	4.70	4.95	5.49	3.39	3.63	4.70	4.21	4.95
16. Teacher gives a short lecture ($\leq$ 50% of the session is teacher talk	3.02	3.35	4.00	2.13	2.41	3.16	3.38	3.13
17. I solve blackboard/ textbook problems by myself.	3.21	2.23	3.57	2.32	2.49	2.72	2.88	2.93
18. I solve textbook problems with my seatmate.	2.74	2.67	2.66	1.79	1.88	2.00	2.56	2.58
19. I hold discussion with a seatmate.	2.79	2.19	2.62	1.89	2.14	2.62	2.35	3.25
20. We hold a small group discussion (5-6 members in a group).	3.98	3.91	4.02	4.29	3.31	3.68	3.38	3.95
21. Use the textbook in class.	1.56	1.95	2.55	1.26	1.14	1.28	1.09	1.80
22. View a CD or video.	4.26	4.37	3.66	3.79	3.86	4.02	3.71	4.10
23. Teacher demonstrates.	3.31	3.56	2.74	2.82	2.88	3.22	3.12	3.50

Table 7.8 (Continued)

Description of Activities	Item Means Per Instructor							
	C	D	E	G	H	K	L	M
24. Teacher gives a seatwork or activity.	1.79	1.47	2.43	1.18	1.16	1.62	1.29	1.38
25. Teacher checks whether I am doing my seatwork.	1.86	1.51	2.70	1.21	1.20	1.66	2.03	1.85
26. Teacher helps me when I have trouble with the seatwork.	1.44	1.70	3.15	1.11	1.39	1.60	3.71	1.60
27. Teacher gives comment about my seatwork.	1.84	1.93	2.94	1.34	1.76	1.88	3.15	2.13
28. Teacher checks whether my classmates are working on the seatwork	1.58	1.35	2.53	1.08	1.27	1.52	2.15	1.55
29. Teacher moves about the class to talk to me or my seatmate or other classmates.	2.14	1.98	3.30	1.42	1.82	2.02	2.88	2.88
30. Teacher reads seatwork of my classmates and reacts.	2.44	2.14	3.17	1.92	1.80	3.04	3.24	3.15
31. Teacher gives grade or score on our seatwork.	4.21	2.81	3.00	3.24	2.59	3.88	2.79	4.05
32. Teacher gives a quiz	2.79	2.93	2.66	4.00	3.22	4.46	1.85	3.38
33. During a quiz or test some/many of my classmates are copying/cheating.	3.23	3.09	3.62	1.45	3.76	2.08	2.18	3.03
34. Teacher gives feedback about a quiz	2.72	3.19	3.74	3.95	2.76	3.50	2.29	3.23
35. I chat with my seatmates while a student is reciting or answering.	3.40	3.07	3.06	1.74	3.37	3.14	2.53	2.80
36. I chat with my seatmate while the teacher is talking or discussing.	3.51	3.37	3.28	1.79	3.20	3.24	2.35	2.78
37. The teacher continues talking even if my classmates are noisy.	2.65	3.65	3.60	1.71	2.96	2.88	2.74	3.15
38. I cannot hear the teacher when he/she is talking/discussing in class.	1.67	2.12	2.81	1.34	2.49	2.82	2.41	2.20
39. The teacher make sure everybody is quiet or settles before he/she starts talking.	1.63	2.28	2.62	1.32	1.84	1.64	2.53	2.13
40. The teacher calls the attention of inattentive students.	2.70	1.79	3.15	1.13	1.71	2.26	2.15	1.63
41. The teacher is consistent in implementing the rules set in this class.	2.33	2.12	2.94	2.11	2.20	2.16	1.94	2.13
42. Teacher gives a summary of the lesson.	2.12	2.53	3.64	1.89	2.63	1.94	3.09	2.65
43. I read topics in the textbook or other references without being told by the teacher.	4.19	3.60	3.83	3.63	4.18	3.74	3.35	4.25
44. I learn from other students in this class.	2.60	2.37	2.32	1.76	2.27	2.16	2.62	3.30
45. I learn some practical applications of chemistry in my daily life.	2.63	1.95	3.30	1.84	2.27	2.50	2.74	2.33

The days schedule of classes were considered in the analysis of the SPNC data for each class due to the use of the alternatives 'Every Class Session' and 'Twice a Week'. The TTh group of students were required to tick on the 'Every Class Session' alternative instead of 'Twice a Week', leaving this group five alternative responses to choose rather than six. The MWF group of students had six alternatives to choose from.

Table 7.9

Mean occurrence of teaching and learning activities per class/instructor

(TTh Group)

Description of Activities	Item Means Per Class/Instructor					
	A	B	F(1)	F(13)	I	J
1. I am absent in this class.	1.39	1.89	1.65	1.97	1.50	1.49
2. I come late.	1.88	2.04	2.96	2.33	1.68	2.30
3. I wear my nametag.	5.94	3.15	1.19	1.38	5.26	5.28
4. I bring my activity notebook for this class.	1.43	1.21	1.00	1.13	1.04	2.26
5. I come to class with textbook.	1.43	1.38	1.27	1.33	1.30	3.60
6. I come to class without textbook.	1.59	1.85	1.42	1.90	1.40	3.81
7. Teacher gives homework for the next session.	2.76	2.36	1.71	2.28	1.50	2.91
8. Homework is clear so I know what to do.	3.08	2.06	1.38	1.92	1.32	2.00
9. I do my homework by myself.	2.98	2.47	2.08	1.90	2.14	2.28
10. Teacher checks whether I have done my homework.	3.63	1.89	2.15	1.51	1.78	2.85
11. Teacher checks whether my homework is correct.	3.90	1.83	2.08	1.51	1.80	1.98
12. Teacher checks several classmates on whether they have done their homework	3.73	1.68	2.25	1.72	2.24	2.77
13. Teacher gives grade or score on our homework.	4.29	2.00	3.63	2.90	3.62	2.15
14. Teacher discusses part or all of our homework.	3.16	1.72	1.35	1.46	1.58	2.00
15. Teacher gives a long lecture (≥ 90% of the session is teacher talk).	4.57	5.02	5.15	4.95	4.72	5.40
16. Teacher gives a short lecture (≤ 50 % of the session is teacher talk	3.55	3.43	3.83	3.51	3.44	3.79
17. I solve blackboard/ textbook problems by myself.	3.22	3.06	2.58	2.51	2.98	3.15
18. I solve textbook problems with my seatmate.	2.80	2.34	1.88	1.90	3.34	2.34
19. I hold discussion with a seatmate.	2.65	1.94	2.02	2.28	2.88	2.53
20. We hold a small group discussion (5-6 members in a group).	3.90	3.91	4.35	4.08	4.52	3.66
21. Use the textbook in class.	1.45	1.38	1.15	1.18	1.28	2.87
22. View a CD or video.	4.55	4.36	5.15	5.00	4.08	4.17
23. Teacher does a demonstration.	3.82	2.17	3.71	2.62	3.18	2.64
24. Teacher gives a seatwork or activity.	1.57	2.02	1.21	1.38	1.32	2.13
25. Teacher checks whether I am doing my seatwork.	2.08	1.70	1.31	1.26	1.44	2.15
26. Teacher helps me when I have trouble with the seatwork.	3.10	1.87	1.33	1.51	1.24	2.38
27. Teacher gives comment about my seatwork.	2.69	2.02	1.71	1.90	1.80	2.30

Table 7.9 (Continued)

Description of Activities	Item Means Per Class/Instructor					
	A	B	F(1)	F(13)	I	J
28. Teacher checks whether my classmates are working on the seatwork	2.02	1.70	1.35	1.26	1.36	1.89
29. Teacher moves about the class to talk to me or my seatmate or other classmates.	2.39	1.89	2.06	2.54	2.56	2.77
30. Teacher reads seatwork of my classmates and reacts.	2.88	2.21	2.48	2.26	2.60	2.89
31. Teacher gives grade or score on our seatwork.	4.41	2.04	3.67	2.79	4.04	2.40
32. Teacher gives a quiz	3.86	3.06	3.83	3.54	3.28	3.15
33. During a quiz or test some/many of my classmates are copying/cheating.	2.65	3.38	1.73	1.67	2.72	2.85
34. Teacher gives feedback about a quiz	4.71	2.60	4.13	3.67	3.38	2.00
35. I chat with my seatmates while a student is reciting or answering.	2.86	3.43	2.17	2.03	2.24	2.77
36. I chat with my seatmate while the teacher is talking or discussing.	2.84	3.45	2.19	1.87	2.22	2.83
37. The teacher continues talking even if my classmates are noisy.	3.57	2.53	1.35	1.59	2.20	2.55
38. I cannot hear the teacher when he/she is talking/discussing in class.	2.57	1.96	1.23	1.36	1.46	1.62
39. The teacher make sure everybody is quiet or settles before he/she starts talking.	2.51	1.62	1.15	1.49	1.82	1.64
40. The teacher calls the attention of inattentive students.	2.55	1.23	1.13	1.28	1.88	1.38
41. The teacher is consistent in implementing the rules set in this class.	3.57	1.85	1.15	1.46	1.98	1.81
42. Teacher gives a summary of the lesson.	4.39	2.40	1.65	1.95	1.90	1.57
43. I read topics in the textbook or other references without being told by the teacher.	3.82	3.30	3.60	3.69	3.52	3.32
44. I learn from other students in this class.	2.59	2.72	2.73	2.92	2.80	2.09
45. I learn some practical applications of chemistry in my daily life.	2.65	2.70	2.21	2.15	2.36	1.74

Note: Instructor F taught two classes, designated classes 1 and 13.

The means of each of the 14 classes were calculated and compared using a One-Way Analysis of Variance (ANOVA) presented in Table 7.10.

Table 7.10

Analysis of variance (ANOVA) of teaching and learning activities of 14 classes using the new teaching approach

Sources of variation	Sum of Squares	Degree of confidence	Mean square	F-ratio	Significance at $p < .05$
Between groups	57.64	13	4.43	15.95	0.00
Within groups	169.62	610	0.28		
Total	227.26	623			

The high significant value of the F-ratio indicated that the items in the SPNC questionnaire could be used to differentiate between perceptions of students in different classes. Thus Scheffé's post-hoc tests were computed to find out those aspects of the new course upon which the instructors differed. Data on the post-hoc test for statistically significant different class are presented in Table 7.11

Table 7.11

Scheffé's post-hoc statistically significant ($p < .05$) multiple comparisons of Chem 4 activities in each class/instructor

Instructor	Instructors which yield significant difference	Class mean	Standard deviation
A	B,F, G, H, I,	3.06	0.53
B	A, E,	2.37	0.81
C	F, G, I	2.88	0.49
E	B, F, G, H, J, K, L	3.18	0.75
F	A, C, E	2.22	0.38
G	A, C, E	2.14	0.36
H	A, E	2.39	0.40
I	A, E	2.41	0.43
J	E	2.63	0.44
K	E	2.59	0.49
L	E	2.53	0.67

Multiple comparisons indicated that Instructors G, E, A, and F were significantly different from the classes Instructors H, K, C, L, B, J, and I. On the other hand, classes taught by Instructors D and M did not yield significant differences with the other 12 classes. It is important to note what is happening in Instructors' A, E, F, and G classes thus this section describes these differences as perceived by the students.

7.4.1 Instructor A's class

Instructor A class was significantly different from classes taught by Instructors B, G, F, and H. Her students perceived that activities such as solving textbook problems with a seatmate (see 18; Table 7.9), holding a small group discussion (see 20; Table 7.9), instructor helping students during seatwork activity (see 26; Table 7.9), giving feedback about a quiz (see 34; Table 7.9), ensuring students were on task (see 25; Table 7.9) and giving a summary or closure (see 42; Table 7.9) occurred once a week in their class, whereas in classes taught by Instructors' B, F, G and H these activities occurred almost every session. Homework assignments were given at least once a week (see 7; Table 7.9) and students did their homework task (see 9; Table 7.9) even though homework questions were vague and broad (see 8; Table 7.9). Besides students claimed that Instructor A rarely checked whether they had done their homework (see 10; Table 7.9) and whether their answers were correct or wrong (see 11; Table 7.9). Sometimes the instructor discussed a part or all of the homework assignments (see 14; Table 7.9).

In addition, Instructor A had difficulty in managing the class. Students rated the activities related to classroom management as rarely occurring (once a week to once a month) in their class. These activities included consistent implementation of rules set in the class (see 41; Table 7.9) and seldom reprimanded inattentive students (see 40; Table 7.9). In addition unwelcome actions, like the instructor talking even when the students were noisy (see 37; Table 7.9), students conversing while someone is discussing (see 35-35; Table 7.9) occurred frequently in this class. Her students gave further comments:

> I was wondering why our teacher hesitates to scold noisy students. The teacher cannot control the class and so we cannot understand the lesson well. (Student # 25; 10/00)

> This class is full of knowledgeable classmates and there are bountiful information asked but the teacher seemed to be less confident of her answers, so the class become noisy and the teacher would no longer react. (Student # 3; 10/00)

Nevertheless Instructor A had a positive attitude towards improving her teaching, even requesting more coaching sessions. The researcher team-taught with her within the first two weeks of the classes. During the post-conferences she admitted that she needed to build her confidence so that she could manage the class adequately. Journal records also indicated that this instructor had some problems with communication skills, and this was perceived to be the root causes of disorganization in her class. It was recommended that rigorous coaching not only on the basic teaching skills, but other personal aspects be considered.

7.4.2 Instructor E's Class

Instructor E's class was found to be statistically different from classes taught by Instructors G, H, K, L, B, J, I and the classes by Instructor F (see Table 7.11). According to the students, short lectures occurred in this class once a month while in the other nine classes this happened more frequently (see 16; Table 7.8). On the other hand, long lecture never happened in Instructor E's class but happened in the other nine classes once a month (see 15; Tables 7.8 and 7.9). Seatwork activity and individual checking on students' task occurred twice a week in this MWF class but every session in the other nine classes (see 24-25; Tables 7.8 and 7.9).

Seatwork activities engaged students in discussion with a seatmate once weekly and in solving problems taken from the textbook only once a month, as compared to the nine classes where these activities happened twice a week and once a week respectively (see 18-19; Tables 7.8 and 7.9). Although this class had seatwork activities twice a week (see 24; Table 7.8), students claimed that activities such as moving around the class and interacting with students (see 29; Table 7.8), helping students when in trouble with the task (see 26; Table 7.8), giving comments about their seatwork (see 27; Table 7.8), and ensuring that all students were on task (see 28; Table 7.8), occurred only once a week rather than every seatwork activity occurrence as happened in the classes of Instructors C, D, G, H, K, M, B, F, I, and J (see 24-29; Tables 7.8 & 7.9).

Another difference pointed out by the students of Instructor E is that seatwork assignments were marked in this class (see 31; Table 7.8) and a quiz was given once a week (see 32; Table 7.8), whereas in classes of Instructors A, C, F, I, K and M had

one seatwork assignment per month that was graded (see 31; Tables 7.8 and 7.9) and a quiz was given once a month in Instructors A, F and G classes (see 31-32; Tables 7.8a & 7.8b) while Instructor K gave a quiz once in a semester (see 32; Table 7.8). In addition, closure or summary of the lesson occurred once a month in this class but implemented in the nine classes at least once a week (see 42; Tables 7.8 & 7.9).
In the implementation of routines, Instructor E did not put emphasis on the bringing of the student's activity notebook and textbook in class, and the textbook was only used once a week, whereas in the other nine classes activity notebook and textbook were used every session up to at least twice a week (see 4-5, 21; Tables 7.8 and 7.9). Regarding homework, the class reported that there was one homework assignments each week and the instructor made a spot-check on homework assignments and conducted a discussion on it. In the other nine classes, these activities happened twice a week rather than once a week (see 7, 10, 12, 14: Tables 7.8 and 7.9).

On the other hand, students perceived that Instructor E was in some ways a good classroom manager. Students' activities like cheating during the quiz and talking while someone is discussing were seldom happening in this class compared to the nine classes, where these activities occurred almost twice a week (see 33, 35-36; Tables 7.8 & 7.9). Instructor E was consistent in implementing the rules agreed in class (see 41; Table 7.8) and called the attention of inattentive students anytime (see 40; Table 7.8). He also indicated during a group discussion that noise and irrelevant interruptions from the students have been minimized.

These results implied that Instructor E was not yet comfortable with the new teaching approach for Chem 4 but was able to manage the class adequately. However, the instructor may have exerted too much control over the students. Sentiments from students echoed this observation:

> We cannot understand the lesson well because the teacher quickly shifts from one activity to another without considering whether the students have finished the task. (Student # 30; 10/00)

I feel that this teacher has no idea of what a consideration is. He does not discuss the lesson clearly; quizzes are difficult and does not listen to complains. He is very strict. (Student # 23; 10/00)

The supervisor's report confirmed this behaviour of the instructor. He reported that,

A variety of approaches were used to engender students being actively engaged. Good use of role-play. In the last part of session, noisy transitions between various sessions features. Many students still working on exercises and students speak away from majority of their peers and speak quietly. There was not enough wait time to bring students attention to instructor. (Treagust, 2000).

7.4.3 Instructor F's Classes

Instructor F taught Chem 4 classes at different times but on the same day schedule. Her students in both classes perceived that the activities related to the instructional cycle model occurred frequently with a well-managed classroom (see 37-41; Table 7.9). Activities that were occurring almost every session were bringing of activity notebook (see 4; Table 7.9), wearing of nametag (see 3, Table 7.9), coming to class with textbook (see 5; Table 7.9), giving clear and well directed homework (see 8; Table 7.9), discussing homework (see 14; Table 7.9); using the textbook (see 21; Table 7.9), implementing seatwork activity (see 24; Table 7.9), checking seatwork assignments individually (see 25; Table 7.9), calling the attention of inattentive students (see 40; Table 7.9) and being consistent in implementing the agreed rules (see 41; Table 7.9). These findings were supplemented by comments of her students such as:

The class is good and well behaved, and I can really understand our teacher. (Student # 25; 10/00)

This a great class, I look forward into going to this class again. (Student # 20; 10/00)

The teacher is strict about discipline, that's why many of us liked her. (Student # 46; 10/00)

The least occurring activities include giving a long lecture (see 15; Table 7.9), holding a small group discussion (see 20; Table 7.9) and viewing videos or CD (see 22; Table 7.9). These behaviours of Instructor F constituted the significant difference from the classes of Instructor C, E and A (see Table 7.11).

Instructor F had been teaching Chem 4 course for more than 15 years. She did not undergo extensive one-to-one coaching during the implementation of the new course but had expressed during a post observation conference that she did not like long lectures even when she was a student. But then she had to do the long lecturing in her class before because she thought college courses should be taught with long lecturing. Besides she had no idea of pedagogy and had less knowledge and experiences of various teaching methods. She always depended on the syllabus provided by the Department, and had been longing for a syllabus or any course material that would guide her to change her teaching method. What she liked in this new course was the opportunity given to the students to express their difficulties to her and she had more time to check on students, whether they were able to follow up the lesson.

7.4.4 Instructor G's class

Students of Instructor G identified seven activities as occurring in their class only once a month such as giving a long lecture (see 15; Table 7.8), holding a small group discussion (see 20, Table 7.8), viewing a CD or video (see 22; Table 7.8), giving a quiz (see 32; Table 7.8), and receiving feedback about the quiz (see 34; Table 7.8), and reading the textbook or any references voluntarily (see 43; Table 7.8). The other activities occurred frequently in a well-organized classroom atmosphere. It should be noted that Instructor G was one of the instructors who implemented the first round of the new course and had undergone rigorous coaching. She later modelled the instructional cycle approach to the other instructors and was confident enough to teach the new Chem 4 course to a special group of chemical engineering students. Her teaching worked well as supported by students' other comments:

> Well, this class is more attentive. Everybody participates in class discussions and activities. The teacher knows how to present the lesson and explain further for us to understand. (Student # 8; 10/00)

Students were asked to comment on the aspects of the course that they would like to improve. The pattern of responses shows these comments:

> I would just like to maintain the way our lesson is taught and the way our teacher handles this class. (Student # 34; 10/00)

> If students don't improve in this class, there's something wrong with the student. (Student # 38; 10/00).

This finding is supported by the report of the researcher's supervisor, who conducted an interview with this class. The report stated that

> generally students appreciated the variety of phases in each session and no one would prefer lectures to 90 % of the time as the usual chemistry class. These different phases helped the students focus on their work and identify problems that could be helped by the instructor. The book, a book used abroad after six years of secondary education rather than four years does not present big problems. Some commented that it is very interesting. (Treagust, 2000)

It should be noted that chemical engineering students have the best admission scores of all engineering students in USC. These students could probably have the best high school background and so the book might be appropriate for them, but not necessarily for other engineering students. The well-implemented course in this class made the significant difference among classes of other instructors.

7.5 Summary

The comments of these students could provide an overview of the overall results of using the instructional cycle model as the teaching approach for the Chem 4 course.

> I like my Chem 4 class better than my high school chemistry. I love the style of teaching in this subject. I am thoroughly learning in this course. It improves my understanding about the material world. (Student # 19 of Instructor G; Student # 43 of Instructor H; 10/00)

> I thought Chem 4 classes are considered difficult but during our class sessions I have understood what chemistry is all about and my classmates help me understand things that before that I didn't understand. The class is cooperative especially the teacher handling the class. (Student # 1 of Instructor F; 10/00)

The results obtained from the two questionnaires indicated that the participating 13 instructors attempted to use and adopt the instructional cycle teaching approach in Chem 4 course. The degree of adoption to the new teaching method varied among the instructors. Successful adoption depends on the two aspects of good mastery of the subject matter and a well-managed classroom. Instructors F and G made major changes to their teaching practices and quickly learned to manage the class effectively. The other seven instructors (B, C, H, I, J, K and M) did make changes to their teaching practices, but these changes were minor, and thus had to be continuously supported and nurtured to prevent them from falling back to the old teaching format. An intensive and continuous peer coaching could work among these instructors.

Instructors E and A also made some changes to their teaching practices, but students claimed that both instructors over-emphasized the completion of all tasks, seatwork and homework assignments, but without providing adequate information, direction and guidance for working on such tasks. The unclear and unsystematic presentation of the lessons contributed to the rising problems on class organization for Instructor A and uncooperativeness of students in the class of Instructor E.

The no statistically significant differences on the implementation of Instructors D and M to the other nine instructors came as a surprise, not because the researcher had biases, but due to the opposing trend between the SPNC questionnaire results and the data collected from videos and post conference sessions. As the researcher looked through all the journal records, she noted a very noisy atmosphere in the classes taught by Instructors D and M and that it was impossible for students to follow instructor's explanation with all students talking to one another. These two instructors asked students to be quiet but there was no persistent follow-up to reprimand students' misbehaviour and this bad situation had occurred for some time.

The journal record also indicated that Instructors D and M were not only being coached regularly but were requesting the coach to team-teach with them. Team teaching occurred frequently in these classes because both admitted difficulty managing the class during the seatwork phase and during shifts between phases. Team teaching could also be a form of peer coaching. Furthermore, the SPNC questionnaire had asked students only to rate on the occurrence of these activities in their classes, but not to identify a specific instructor teaching the course. This could be a limitation of the SPNC questionnaire used in this study.

CHAPTER 8
CONCLUSIONS, IMPLICATIONS AND LIMITATIONS

8.0 Overview

The researcher's impressions and comments of the instructors, as well as perceptions provided by students, showed that the course development process was able to create visible changes in classroom teaching and learning and that it generated a teacher development process. The outcomes of the study are centred on the instructional cycle model and improvements in basic teaching skills in the classroom, instructors' relearning from their own experience as well as the spirit of collegiality developed in the Department.

This chapter is divided into three main sections: conclusions, limitations and implications. The first section is focused on the research questions posed in Chapter 1 where each question is answered and discussed based on the evidences and outcomes of the data presented in Chapters 4, 5, 6 and 7. The second section describes the limitations of the study context and the research methodology in order to address issues of validity, reliability, and generalisability. The final section examines the implications of the study and the future direction of the research project.

8.1 Conclusions

In concluding this study, research questions are answered and discussed.

8.1.1 Research question 1

> How can course material be developed to maximize students' intellectual engagement, given current Philippine conditions?

The pre-project data confirmed that chalk and talk lecture method and students' being passive in class dominated college chemistry teaching at the University of San Carlos. There were no systematic and sustained efforts by instructors to stimulate and maintain student engagement in introductory chemistry courses with large enrolments. Likewise, the General Chemistry course syllabus was so broad that it did not provide the instructors with sufficient guidance to encourage students to be continuously on task in and outside of class. Recognising these problems besetting the college chemistry classrooms in the university and the capability of the instructors to undergo substantial changes in their teaching methods, a three-phased instructional cycle (plenary-seatwork activity-closure or summary) was applied in restructuring a General Chemistry course. A Chem 4 course manual intended for instructors' use was prepared in order to guide the instructors with the implementation of the instructional cycle model as a teaching approach for the course. The course material was pilot-tested and revised twice before the majority of the instructors in the Department used it.

The instructional cycle model bridges the gap between the traditional long lecture mode of delivery and a student-centred mode of teaching. The plenary phase enabled the instructors to apply their lecturing skills in presenting chemistry information or topics to the students. The seatwork activity phase enabled the students to engage in tasks related to the presented information or topics with guidance from the instructor, who continuously moved around to monitor students' tasks and give feedback. Finally, the lesson terminates with a summary and homework assignments given to students as an independent practice on the concepts and skills learned.

8.1.2 Research question 2a

> How effective was the implementation of the teaching/learning model in terms of instructors adopting or adapting the three phases in the approach?

The results obtained from the various sources of data indicate that the participating 13 instructors implemented the new Chem 4 course reasonably well. The model enabled the instructors to reduce lecturing and increase opportunities for students to be engaged in an in-class task during the seatwork activity phase and in out-of-classroom tasks in the form of homework assignments. However, the extent to which these instructors adapted the instructional cycle varied to a considerable degree. The three categories of instructors identified in the study — successful, moderate and unsuccessful — do not represent an exhaustive taxonomy, but rather is a simplification to determine the extent of the instructors' adoption or adaptation of the new pedagogy. Salient characteristics of three successful instructors were the ability to condense essential subject content in a mini-lecture, to carry out seamless transitions between phases, to interact more with individual students and quickly spot students' difficulties or unique ideas as a springboard for the closure or summary phase. An adequate level of content knowledge and good skills in classroom management were important tools to successful implementation of the new course.

The seven moderately successful implementers had shown determination to use the class time maximally; however, they tended to use more than 50% of the actual class time giving lectures during the plenary and closure/summary phases than providing students with sufficient time to work with seatwork assignments (seatwork activity phase). Adoption of the instructional cycle required important skills which this group of instructors had not acquired when giving their long lectures. These skills were: condensing essentials in the topic into a mini-lecture and properly distinguishing main points from details; listening to students during seatwork and small group discussion and identifying misconceptions; assessing students' work and using students' ideas effectively as a basis for feedback and for the closure of the lesson are skills that this category of instructors can improve upon.

The three less successful instructors had great desire to continuously use the instructional cycle approach but were hindered by the lack of necessary skills of classroom management and insufficient content knowledge mastery.

8.1.3 Research question 2b

> How effective was the implementation of the teaching/learning model in improving basics of classroom management: books, use of class time, tardiness, attendance, seamless transitions between phases, maximum use of homework and monitoring of students' performance?

The implementation of the plenary-seatwork-closure or summary phases in Chem 4 paved the way for the marked improvement of basic teaching skills that included optimal use of class time, efficient use of actual teaching time, monitoring of student attendance and tardiness, efficient use of textbook, implementation of routines, giving and monitoring of homework assignments, making seamless transitions during shifts between phases, handling misbehaviour of students and monitoring and helping students remain on task. These fundamental skills are often neglected and abandoned by college instructors because of the perception that they are of little value, and the belief that college students are mature enough to handle their own learning even without adequate guidance from instructors.

8.1.4 Research question 2c

How effective was the implementation of the teaching/learning model in enhancing instructors' pedagogical repertoire?

The use of the simple instructional cycle as the teaching scheme contributed considerably to the improvement of the instructors' pedagogical repertoire. The plenary phase enabled the instructors to condense topic details into a meaningful mini-lecture and to ask questions that stimulated ideas and called for higher order thinking skills. The seatwork activity phase facilitated the instructors to learn to interact meaningfully about the subject matter with individual students and in small groups, guiding students on the maximum use of the textbook and assessing students' work and ideas effectively. The closure or summary phase helped the instructors to acquire the skills in using students' work and opinion as the basis for feedback and development of concepts.

The giving and checking of homework and the use of textbooks during every session became part of the instructors' repertoire so that the students developed the habit of working independently on homework. Managing the class efficiently during shifts from one phase to another and monitoring the work atmosphere in large enrolments of Introductory Chemistry courses and admonishing undesirable students' behaviours when necessary provided challenges to the classroom management skills of the instructors.

Although not all of the instructors learned these skills immediately, the coaching process also had contributed significantly to their gradual acquisition of these skills. Furthermore, the researcher is not suggesting that the instructional cycle teaching approach used to reconceptualize Chem 4 course is the only or best approach to facilitate improvements in the teaching of chemistry. The researcher is arguing that the instructional method appears to have considerable positive effect for instructors who utilize and choose to use such a method of teaching. If college instructors wish to have students more satisfied with and enjoying their science courses, classes should be task-oriented, allow opportunities for individualization and interact more with the students (Caprio, 1997; Leonard, 1997).

8.1.5 Research question 3

How has the project enhanced inter-faculty collegiality/collaboration?

While the instructors were undergoing mental disequilibrium trying to unlearn previous practices and learn the new pedagogy, coaching offered opportunities to support one another. The instructors' teaching gradually changed and the Department's culture changed as well. Evidences of these changes are instructors talking about teaching practice, sharing materials and ideas, seeking help with difficult chemistry concepts and giving one another technical feedback as they practiced the new teaching model. The instructors were also talking about their successes and frustrations with the instructional cycle model and were experiencing a reduced sense of isolation. Collegiality has become the norm in this once business-only atmosphere of the Department. Shared goals lead to common expectations and standards and collaboration leads to better and more comprehensive learning opportunities for students. Likewise, many studies also demonstrated that instructors work better in groups than they do when isolated, and that incentives alone do not determine product output (Dillon, 2000).

8.1.6 Research question 4

What are students' perceptions of the teaching/learning approach?

The students expressed positively that the teaching approach in their Chem 4 course enabled them to acquire discipline in coming to class on time with their activity notebooks and textbooks. Instructors' monitoring and checking on homework assignments encouraged them to read the textbook and other resources, thus improving not only their preparation for the lesson but their understanding of the concepts as well. This procedure eventually led to students being responsible for their own learning. The activity phase provided an opportunity for students to be mentally active and realize that sharing of ideas during small group discussion enhanced their learning capabilities, confidence and understanding of the chemistry concepts taught.

In addition, students expressed concern over instructors' inability to maintain a well-organized class so that the classroom environment was conducive to learning. Although students recognized the efficacy of reducing lecture time and more time for seatwork, they claimed that certain amount of voice and choice on their classroom activities be heard and considered by the instructors.

8.2 Limitations

The research had limitations in terms of two aspects; the limitations of the study and the limitations of the research design. The emphasis of this section is on the limitations of the research design in order to address the issue of validity and reliability to indicate that when generalisations are made, they may be treated with caution.

8.2.1 Limitations of study context

In the long term one would want to make very big changes in the teaching and learning in the General Chemistry course. Such long term changes would include: (a) a shift from teacher centred lecturing to student centred learning, (b) a move toward more emphasis on concepts and conceptual development and remediation of popular misconceptions, (c) integration of laboratory and theory or at least more coordination between the two, and (d) inclusion of the use of media such as computer simulations related to difficult topics such as chemical bonding and atomic structure.

Considering the current background and experience of instructors in the study, it is obvious that this process would take many years. Moreover, after a start, instructors would have to participate in determining which direction to go, so the end state of a reform and development process of many years should not be determined ahead of time, although one certainly needs a long term vision. The thesis fieldwork included two semesters of piloting and revising the course and one semester of large-scale implementation where instructors went through a deep implementation dip. It does not make sense to study student achievement outcomes until implementation is smooth and as intended for a whole semester, that would then in the second or better in the third semester of implementation.

Although this study was successful in initiating change in the teaching of the Chem 4 course, the study was limited in one way. The researcher cannot avoid asking the question, whether the instructors really wanted to change their practice or were they under Department and University pressure? Changes can improve performance through making people feel important. The apparent acceptability and the unanimous decision made by the instructors and the Department to implement the new course, could give rise to the Hawthorne effect, namely the theory that instructors will perform better when they are given special attention.

Probably, the Hawthorne effect was high in the initial stages of the implementation of the study, but since the implementation extended over a long time period, the consequences of newness and attractiveness over the time were greatly reduced and the Hawthorne effect became less influential. However, extended contact with the visible effectiveness of the new model most likely reduced the effect of this limitation on the study.

8.2.2 Limitations of the research methodology

The credibility and generalisability of the results could be affected by the methodology used in the conduct of the study. One limitation related to the methodology is subjectivity of which the researcher identified two sources. One is the question whether or not the students truthfully responded to the interviews or questionnaires, or were they just being polite? Another is the researcher's familiarity with her colleagues, the instructors, as she had been in the Department for more than 15 years. The long period of contact between the researcher and the participating instructors may have contributed to a bias of the researcher's own subjective views. Subjectivity is inescapable in the collection and reporting of data. In order to counteract this inherent subjectivity, the researcher collected a range of data from various sources: video records, observation notes, journal records of instructors and the researcher, interviews, and students' perception questionnaires of the classroom practices. The use of triangulation within the study as a process in collating and analysing the data collected from these sources reduced the degree of subjectivity bias.

The second limitation, related to the methodology, is the fact that the researcher was the only researcher for the study. An attempt was made to overcome this limitation when the researcher used audiotape recordings of interviews with students and videorecordings of classroom teaching. These mechanically recorded data were examined and reviewed by a group of examiners who are competent but independent and had no interest in any part of the study. Likewise, observation reports of the supervisor, associate supervisor, chairperson of the Chemistry Department and a content-expert colleague added to the validity of data and results obtained.

The third limitation is related to the inability of the researcher to conduct a follow-up interview for students with conflicting answers in the questionnaires. For example, on the SPNC questionnaire statements, 'I come to class with textbook and I come to class without textbook,' few students had the same answers in every session for both questions. These answers indicated inconsistency of practice and were difficult to rate without verifying such answers during interviews with students. These inconsistencies may have limited the scope of generalisation of the study.

8.3 Implications

This study has provided a description of the classroom practices of 17 instructors and the development process of 13 college chemistry instructors during the reconstruction of the General Chemistry course — in University of San Carlos. This small number of instructors in one department represents a microcosm of college instructors in the University and across the nation. They have information to share about the gains, difficulties and other learning experiences derived from using the instructional cycle model in teaching. A facilitating factor of the instructional cycle model is that instructors can still use a short lecture, which they are used to doing, at the same time they can explore varied ways of seatwork activities and homework assignments. The insights and opinions gathered from instructors and students can be used to identify specific problems and needs that could be addressed when other departments, colleges or universities intend to develop their own courses.

One of the emphases of this study is the need for the instructors to acquire the basic teaching skills in the college classroom before any complex educational actions can be taken in class. Keeping a well-organized learning environment requires college instructors to learn the skills of classroom management so that teaching becomes effective and learning is more active and meaningful.

Another feature of the study that is relevant to administrators and training institutes is the importance of coaching as a method of support to instructors while undergoing change. The collegial atmosphere and long-term effects of coaching shown in this study corroborate claims in the literature. It is therefore recommended that a coaching program be a part of any faculty development program, even at the college or university level.

8.3.1 Future directions

The course and faculty development described in this study was only an initial step of many more to be taken. Once the basic teaching skills have been addressed such as students being present and on time, books brought to class, seatwork organized and running, students being at work, the focus of development of teaching and learning can move to conceptual development, retention rates and meaningful learning. This process will require a major effort from instructors and students and will be a long-term learning process as both students and instructors have been participants in a teaching system that is, up until now, based heavily on memory and is fact-oriented.

Considering the initial level of subject matter mastery and pedagogical content knowledge of the instructors and the long term changes desired, this study could only be a first step of many, but a big step. Shifting from 100% lectures to 50% lecture and 50% students work or activities and to a new sequence and new instructional materials is a big step. Instructors will naturally go through an implementation dip before attaining proficiency and before one can expect major improvements in student achievement. It is only after instructors improve their own subject mastery and overcome their own misconceptions that they will be able to move toward more emphasis on concepts and conceptual development and that the first major improvements are expected. Therefore in this study the researcher focussed on instructor development and classroom implementation of the instruction cycle. Student achievement is not yet included in the design of this study for the reasons outlined above. The use of interactive demonstrations has been included in various training sessions in small groups as well as instructors meetings, however, the first priority was the implementation of the instructional cycle. Later in the process interactive demonstrations and their relation with conceptual development will receive a higher priority.

After the restructuring of the Chem 4 General Chemistry course described in this study, the Chemistry Department redeveloped and implemented four more courses while also continuing to make improvements in the Chem 4 course. In each course, the emphasis in the development process was on selecting/creating meaningful seatwork assignments around the conceptual bottlenecks in the course. A similar process of course and faculty development has started in the Mathematics and Physics Departments. At the same time, three doctoral research projects described the development of students' conceptions in optics, chemical equilibrium, and algebra in classes taught by the respective researchers who were able to master a much greater range of teaching skills than their colleagues. These topics are taught using sophisticated conceptual development and inquiry strategies and the studies will act as the long-term target for development of the teaching of their colleagues. The chemical equilibrium classroom study has already led to a series of faculty seminars on the key concepts and the pedagogy of teaching them.

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APPENDICES

Appendix A

Video Coding Matrix

Name of Teacher ________________________ Class Schedule ___________
Date of Videotape ______________________ Observer _______________
Topic/s: ____

Official time: ________ minutes
Actual total time used: _________ minutes

I. Plenary Phase	**I**		**II**		**III**	
	yes	**no**	**yes**	**no**	**yes**	**no**
1. What was included in the plenary?						
* lesson review (initiated by the teacher)						
The lesson review is about ______						
* lecture on new topic or skills						
* reteach						
Reasons for the reteach: a. response to student's questions ☐ b. students misunderstood the lesson ☐						
* combination of lecture and question						
* combination of lecture and writing notes on the board						
* combination of lecture, questioning and writing notes on the board						
* instructions on what students should do during seatwork						
* illustrate a part of the seatwork						
* demonstrate a small part of the activity						
* other (please specify)						
2. Did the teacher control and maintain student discipline during the plenary?						
3. Did the teacher give a clear plenary presentation?						
4. How many questions did the teacher ask during plenary?						

5. How many questions (referring to teacher's questions) were answered:	* in chorus? ____ *individually? ____ *by teacher ____	* in chorus? ____ *individually? ____ *by teacher ____	* in chorus? ____ *individually? ____ *by teacher ____

6. Were the questions asked by the teacher able to:
* stimulate ideas ☐ * check students' understanding ☐

7. What type of questions frequently asked by the teacher?
* low level ☐ * high level ☐
7.1 Write a sample question for:
low level:____________________

high level:

8. How many questions did the students ask during plenary?

9. What type of questions frequently asked by the students?
* low level ☐ * high level ☐
9.1 Write a sample question for:
- low level ____________________
- high level:

10. How many questions asked by students were answered by:
* a classmate ________ * the teacher ________ * himself/herself ________

11. What is the total time spent for each plenary?	min	min	min

12. Other comments about the plenary phase.

B. Seatwork Phase	**I**			**II**			**III**		
	yes	**no**	**min**	**yes**	**no**	**min**	**yes**	**no**	**min**
1. Was there a seatwork?									

	yes	**no**	**yes**	**no**	**yes**	**no**
2. How was the seatwork done?						
*individually						
*pairs						
*small group (4-6 students)						
3.Was the seatwork graded?						
4. What did the teacher do during seatwork?						
* moves around to ensure that students start immediately						
* moves around to ensure that students are at work						
* goes around and look at students' paper						
* interacts with students						

* interacts with students: *individually ☐ *in small group ☐ * as a whole class ☐

	I		**II**		**III**	
	yes	**no**	**yes**	**no**	**yes**	**no**

* controls and maintains discipline						
* writes notes on the board						
* prepares materials like OHP,VHS,etc.						
* sits and do other work like checking papers, reading, etc.						
* leaves the room						
* other (specify)						
5. Did it take long for the students to start the seatwork?						
6. If yes (referring to no. 4 answer) what are the causes of the delay?						
7.What % (estimate) of students was actively at work most of the time? * >70 % * 41-70 % * 10-40 % * less than 10 %						
8.What were the students doing during seatwork?						
* answer/discuss low level questions						
* answer/discuss high level questions						
* read a topic from a textbook						
* solve some problems at the end of a chapter in the book						
* perform a short experiment or demonstration						
* solve situational problem						
* interpret a given data, construct graph and make an inference						
* make concept map						
* discuss ideas with a seatmate or within a group						
* write answer or solution on the board (boardwork)						
* other (please describe)						
9. Other comments about the seatwork phase.						
C. Closure/Summary Phase (done right after a seatwork/activity)						
1. How much time was spent for this phase of the session?	min		min		min	
	I		**II**		**III**	
	yes	**no**	**yes**	**no**	**yes**	**no**
2. What did the teacher do in this part of the session?						
* reads the seatwork questions and immediately answers each						
* writes the answers on the board						

* encourages students to react to one another						
* reacts on the answer/response of student						
* discusses common errors and misunderstandings of concepts discovered during seatwork (corrective feedback)						
* conducts instructional reinforcement						
* gives a summary of the lesson or activity						
* relates this discussion to the previous lesson/next lesson						
* other (specify)						
3. What did the students do in this part of the session?						
* presents orally the answers to the seatwork questions to the class						
* gives oral report about the seatwork/activity to the class						
* discusses his/her boardwork						
* summarizes the activity						
* other (specify)						
4. How many questions did the teacher ask during this phase?						
5.How many questions (referring to teacher's questions) were answered:	* in chorus? ______ *individually? ______ *by teacher ______		* in chorus? ______ *individually? ______ *by teacher ______		* in chorus? ______ *individually? ______ *by teacher ______	
6. Other comments about this phase.						

D. Homework

	yes	no
1. Did the teacher check homework?		
2. How was the checking done?		
* random checking		
* through a quiz		
* collecting a paper		
* other (please specify)		
3. Did the teacher give homework?		
4. Was the given homework:		
* written on the board?		
* dictated?		
* clear?		
* unclear?		
* specific?		
* general/broad?		
* attainable within the given time frame?		

* low level		
* high level		
5. Other comments about homework		
E. Classroom Management		
1. Was there a check on:		
* attendance		
* tardiness		
* textbook		
2. Which of these behaviors were manifested by the teacher?		
* gives a lot of encouragement		
* listens actively		
* controls discipline during transitions between phases		
* controls and maintains student discipline throughout the session		
* addresses the right undisciplined students		
* indicates how students should improve their behavior		
* rewards desired answer and behavior of students		
* pays attention to a good working environment		
* other (please specify)		

F. Other comments about this class:

Malou/March, 2001

Appendix B

Class Observation Form

Classroom Observation Form				
Instructor:				
Subject:				
Observer:				
Date:				
	+	±	-	n/a
1. Start of the Lesson				
Indicates when the lesson starts				
Indicates which behavior of the students is expected				
Indicates what students need for the lesson				
Checks if the students have the correct materials in front of them				
Reviews the required starting knowledge				
Gives lesson objectives or lesson overview				
2. Checking homework				
Spends time and attention to homework				
Checks whether students made homework				
3. Explanation of new content				
Provides structure when explaining				
Writes key concepts on the board				
Asks questions to check if students understood the explanations				
Makes sure that all students remain interested and with attention				
4. Giving instructions for classroom activities				
Provides clear instructions				
Writes on blackboard what students should do				
Demonstrates a small part of the activity				
Indicates how much time students have available				
Indicates clearly what students are expected to do when ready				
5. Independent work of students on activities				
Makes sure that students start immediately				
Makes sure that all students are at work				
Goes around the room to check student work and to assist individuals/groups				
Replies to answers after students have tried for themselves				
Checks if all students are working seriously				
Makes sure that students do not have to wait too long when raising their hands				
Gives students appropriate feedback				

6. Discussion and checking activities at classroom level				
Writes notes on the blackboard				
Checks whether students have corrected their work				
7. Giving homework				
Writes homework on blackboard				
Indicated how students should make their homework				
Makes sure that students write down their homework				
8. Progress of the Lesson				
Checks what happens in the classroom				
Spreads questions across many different students				
Encourages that students react to each other				
Gives feedback on thinking processes				
Gives a lot of encouragement				
Transitions between phases are smooth				
Controls the time				
Listens actively				
9. Attention and participation of students				
Controls discipline				
Addresses the right undisciplined students				
Indicated how students should improve their behavior				
Rewards desired behavior				
Pays attention to a good working atmosphere				
10. Rules				
Entering and leaving the classroom				
Asking information by students				
Assistance when doing seatwork				
Handing in of activities and assignments				
11. Classroom organization				
Makes sure to overview all students				
Makes sure that all students can see what's on the blackboard				

1. General impression of the lesson:

Appendix C

COLLEGE AND UNIVERSITY CLASSROOM ENVIRONMENT INVENTORY (CUCEI)

Name of Teacher: ______________________ Class Schedule __________

Directions

This questionnaire is designed for use in gathering opinions about classes at universities or colleges. Its purpose is to find out your opinions about the Chem. 4 class you are attending now.

This form of the questionnaire assesses your opinion about what this class is actually. Indicate your opinion about each questionnaire statement by checking:

SA if you STRONGLY AGREE that it describes what this class is actually like.

A if you AGREE that it describes what this class is actually like.

D if you DISAGREE that it describes what this class is actually like.

SD if you STRONGLY DISAGREE that it describes what this class is actually like.

	SA	A	D	SD
1. The instructor considers students' feelings.				
2. The instructor talks rather than listens.				
3. The class is made up of individuals who don't know each other well.				
4. The students look forward to coming to this class.				
5. Students know exactly what has to be done in our class.				
6. New ideas are seldom tried out in this class.				
7. All students in this class are expected to do the same work, in the same way and in the same time.				
8. The instructor talks individually with students.				
9. Students put effort into what they do in this class.				
10. Each student knows the other members of the class by their first names.				
11. Students are dissatisfied with what is done in this class.				
12. Getting a certain amount of work done is important in this class.				
13. New and different ways of teaching are seldom used in this class.				

14. Students are generally allowed to work at their own pace.				
15. The instructor goes out of his/her way to help students.				
16. Students "clockwatch" in this class.				
17. Friendships are made among students in this class.				
18. After the class, the students have a sense of satisfaction.				
19. The class often gets sidetracked instead of sticking to the point.				
20. The instructor thinks up innovative activities for students to do.				
21. Students have a say in how class time is spent.				
22. The instructor helps each student who is having trouble with the work.				
23. Students in this class pay attention to what others are saying.				
24. Students don't have much chance to get to know each other in this class.				
25. Class meetings are a waste of time in this course.				
26. This is a disorganized class.				
27. Teaching approaches in this class are characterized by innovation and variety.				
28. Students are allowed to choose activities and how they will work.				
29. The instructor seldom moves around the classroom to talk with students.				
30. Students seldom present their work to the class.				
31. It takes a long time to get to know everybody by his/her first name in this class.				
32. Class meetings are boring.				
33. Class assignments and seatwork are clear so everyone knows what to do.				
34. The seating in this class is arranged in the same way each week.				
35. Teaching approaches allow students to proceed at their own pace.				
36. The instructor isn't interested in students' problems.				
37. There are opportunities for students to express opinions in this class.				
38. Students in this class get to know each other well.				
39. Students enjoy going to this class.				
40. This class seldom starts on time.				
41. The instructor often thinks of unusual class activities.				
42. There is little opportunity for a student to pursue				

his/her particular interest in this class.				
43. The instructor is unfriendly and inconsiderate toward students.				
44. The instructor dominates class discussions.				
45. Students in this class aren't very interested in getting to know other students.				
46. Class are interesting.				
47. Activities in this class are clearly and carefully planned.				
48. Students seem to do the same type of activities every session.				
49. It is the instructor who decides what will be done in this class.				

Appendix D

Students' Perceptions of the New Chem 4 Course (SPNC)

Name of Teacher________________ Class Schedule ________________

A. Please check the column how often these activities occur in your Chem 4 class.

Approximately, how often in Chem 4 sessions do the following activities take place?	Every class session	Twice a week for MWF	Once a week	Once a month	Once a semester	Never
1. I am absent in this class.						
2. I come late.						
3. I wear my nametag.						
4. I bring my activity notebook for this class.						
5. I come to class with textbook.						
6. I come to class without textbook.						
7. Teacher gives homework for the next session.						
8. Homework is clear so I know what to do.						
9. I do my homework by myself.						
10. Teacher checks whether I have done my homework.						
11.Teacher checks whether my homework is correct.						
12.Teacher checks several classmates on whether they have done their homework						
13. Teacher gives grade or score on our homework.						
14. Teacher discusses part or all of our homework.						
15. Teacher gives a long lecture ($\geq$ 90% of the session is teacher talk).						
16. Teacher gives a short lecture ($\leq$ 50 % of the session is teacher talk						
17. I solve blackboard/ textbook problems by myself.						
18. I solve textbook problems with my seatmate.						

19. I hold discussion with a seatmate.						
20. We hold a small group discussion (5-6 members in a group).						
21. Use the textbook in class.						
22. View a CD or video.						
23.Teacher does a demonstration.						
24. Teacher gives a seatwork or activity.						
25. Teacher checks whether I am doing my seatwork.						
26. Teacher helps me when I have trouble with the seatwork.						
27.Teacher gives comment about my seatwork.						
28.Teacher checks whether my classmates are working on the seatwork						
29. Teacher moves about the class to talk to me or my seatmate or other classmates.						
30.Teacher reads seatwork of my classmates and reacts.						
31. Teacher gives grade or score on our seatwork.						
32. Teacher gives a quiz						
33. During a quiz or test some/many of my classmates are copying/cheating.						
34. Teacher gives feedback about a quiz						
35. I chat with my seatmates while a student is reciting or answering.						
36. I chat with my seatmate while the teacher is talking or discussing.						
37. The teacher continues talking even if my classmates are noisy.						
38. I cannot hear the teacher when he/she is talking/discussing in class.						
39. The teacher make sure everybody is quiet or settles before he/she starts talking.						

40. The teacher calls the attention of inattentive students.						
41. The teacher is consistent in implementing the rules set in this class.						
42. Teacher gives a summary of the lesson.						
43. I read topics in the textbook or other references without being told by the teacher.						
44. I learn from other students in this class.						
45. I learn some practical applications of chemistry in my daily life.						

B. Other comments about this class:

C. What would you like to improve in Chem 4 class?

USC Chem Dept
Oct, 2000

Appendix E

Journal Guide Given to Instructors During Weekly Sessions

Name: Week: from.../...to.../...

Date:

A. General Impression of the Week

- What was your overall impression?

- How did the different lessons go?

B. Reflection on one particular lesson

- What was your general impression? (What do you remember most, either positive or negative?)

- Did you achieve your objectives? How did you verify this?

- Did you feel (not) confident? Give at least two reasons.

- How was the working atmosphere in the classroom? Explain.

C. What did require special attention?

- Was there any unexpected event? You can also mention something that did not go well, or even went wrong. Describe that situation as completely as possible. What was the cause and what was the effect?

Appendix F

Guide Questions Given to Instructors Before a Monthly Whole Group Session

August 24, 2000

Dear Colleagues,

It is now the third month of implementing the reconstructed material for Chem 4. At this time you have many thoughts/ideas to share to me and to our colleagues regarding your experience (frustration, personal encouragement, own learning) with the new class meeting scheme. So that you will be guided and focused in your reflection, the following are some questions:

What are the teaching elements that went fine?

What aspects of your teaching do you like most?

What do you see wrong with your teaching?

What would you like to see changed?

Where to concentrate on for improvement ?

I would appreciate it much if you can write your reflection on a paper and bring it on Saturday (August 26, 8:30 a.m.).

Thanks a lot for all your support. I'm inspired by your cooperation and enthusiasm that the STEPS decision to make the Chem dept as the pilot study for its course development project is really worthwhile.

Malou

Appendix G

Sample of Researcher's Journal Record

I. October-November 1999:Course reconstruction workshop/Preparation of Chem 4 course manual for teachers and students

Between October and November, 1999 I attended a course reconstruction seminar-workshop conducted by a Ad Roojakers, a Dutch Fellow whose expertise was on course development. The seminar provided a good input on the basic things that must be included in the course reconstruction. The resource speaker explained the basics in the learning process which include the orientation, exercise and feedback. Orientation as I understood included the theory, the way to think and use about the content. The exercise is for the students to do action and is dependent on the information given in the orientation while the feedback portion is making the students aware of their learning or steering the students thinking. These were the parts of the cycle I used during the preparation of the Chem 4 course material and this is where I derived the classroom scheme which the plenary------ activity----- closure model I introduced in the pilot study. Two colleagues who had also attended the above seminar-workshop were chosen to implement the Chem 4 pilot study. One colleague had been teaching Chem 4 for 12 years while the other had 3 years teaching experience in the same course.

II. The Pilot Study

A. Profile of Students in Chem 4

There were two Chem 4 classes offered for this semester (2nd semester, 1999-2000). The MWF group had 56 students who were officially enrolled. Fifty students took the midterm examination and were regular attendees in the class. 32 students (59%) were repeaters while 22(41%) were first time takers of the course. Of the 32 repeaters, two students took the course twice, one student had taken it thrice and one had repeated the course four times.

The TTh group had 55 officially enrolled students but only 43 took the midterm exam and were regular attendees in the class. One student had officially withdrawn from the course; four students did not attend the course at all and seven students attended 2-5 sessions only and didn't come back anymore. Of the regular attendees, 22(51%) students were repeaters, while 21 (49%) were non repeaters.

B. Some Basic Concerns

The task during semester 2 was not only focused on the development of Chem 4 course material but also looking at the basic concerns in the classes. Such concerns include the textbook of the students, attendance, tardiness, homework, activities and classroom management.

b.1 Textbook

At the start of the semester, the students were required of a textbook. Textbook was to be used every class session for the student's reference of their exercises and class activities. The bringing of textbook every session was required and a deadline was set for the students to acquire a copy. Students were given a month to comply this requirement. Within this time frame, I explored the availability of the textbook and found out that local bookstores were selling at an affordable price; likewise, the university's textbook department had enough copies of these books for loan within a semester at P 65.00/ semester. This was a minimal amount which all our students can afford. Moreover, the university's science library had four copies, two were in the reserved section for the students to borrow anytime and two were in general reference for three days loan.

After the deadline, we checked the books of the students and to our dismay only 12 students out of 50 have books brought in class. We were irritated by this gesture of the students and so we decided to send those students, who do not have books, out from our class session for that day. In the stricter sense, I didn't like our action of sending the students out, however, we have to cross our fingers otherwise only few will participate during class activities or exercise. The following meeting only three students out of 45 did not have books. From then on majority of the students are now bringing books in our class though there were still students who can't really follow for reasons such as forgetting to bring and losing the books.

The usual practice of many teachers in the department is to inform the students of the required textbook for Chem 4 by giving the authors' name and title of the book. No effort was done to check the textbooks of the students and were rarely used during classes. Eric Mazur (1997) pointed out that it is important to get students to read the textbook and do part of the work ahead of the lecture.

b.2 Tardiness

I had noticed that tardiness was common in these classes. Late comers disturb both the teacher and the class during plenary and group work because they keep on asking questions on topics that they missed. Each session about 6-10 students coming in late of more than 15 minutes, despite the university's policy on late comers. The policy allowed 15 minutes late for the students to be admitted in class and beyond that an absence is incurred. One reason why students were late was the successive schedule of classes at the College of Engineering. The building was about 100 meters far from the Science building where Chemistry classes were held in the third floor. It was a normal operating procedure in this university that a warning bell was given five minutes before the dismissal time. This was to give enough time for the students to transfer from one room to another. Despite these provisions a substantial number of students keep coming late and teachers were unmindful of the situation.

To prevent tardiness in our class, the students and the teacher agreed that nobody will be allowed to enter the classroom after 15 minutes and the door will be closed. During the first week of implementation of this agreement, two to three students came in late and insisted to come in. The reasons for being late were: traffic congestion, far distance of residence and oversleeping. These reasons were invalid and so they're denied entry in the classroom for that session. The next sessions had no late comers anymore although the closing of the door after fifteen minutes was still the practice.

b.3 Assignments

"Before I am not motivated to work on the assignment. My teacher didn't check them. 60 % of my assignments done were copied from classmates and sometimes I let my classmates copy from me. Anyway, the teacher never discussed the assignment. Now, the teacher gave assignments every session. The teacher had different ways of checking the assignment; either through a short quiz, random checking in notebooks or passing them on paper." This was quoted from few students who were interviewed.

Usually assignments were seldom given in Chem 4 courses. If given, it was used to get the students to read the topics for future discussion. In my experience the most common assignment task was solving problem sets either provided by the teacher or taken from the textbook. In many cases, checking the assignment was rarely done and most often students don't work on their assignment.

Recently, the course material developed for Chem 4 included assignments every session. The assignments included readings certain pages in the textbook/references and note down definition of terms, solving exercises at the end of the chapter in the textbook and answering practical questions in preparation for a class debate. There were two ways employed by the two teachers to check the assignments. One way was to give 5-10 item quiz on definition of terms or give a brief description of a concept. The quiz results showed that no student in both groups got the correct answers in all the questions given. Few students (13 out of 38 for TTh group and 10 out of 47 for MWF group) got a partially correct answer. Partially correct means that key words are present but the logical presentation of the idea was missing.

Another way was to ask the students to write their assignment on paper and submit them after which a follow up discussion was given by the teacher. The follow up was seldom undertaken by the teacher.

b.4 Getting acquainted with the students/monitoring of attendance

The usual practice in knowing the students in one's class was to have a seat plan. The seat plan was the basis for checking attendance of the students which was usually done at the start of the period. The two teachers found difficulty in knowing the students by their names using only the seat plan particularly when seating arrangements were no longer followed during the group activities. They decided to provide name tags to each student. Each student upon entering the class got his name tag and wore it during the session. At the end of the class name tags were returned to the teacher and the later used them to check the attendance of the students. During the student activity session, name tags were useful in calling the attention of students who don't worked on the activity immediately. On the other hand, it was useful in recognizing students who were actively and sensibly participating in the activities. Name tags served as one way of monitoring attendance and getting acquainted with the students however a problem was identified with the use of name tags. Some students not only got their name tag but also the name tags of friends who were late and probably absent. I informed the teachers about this misbehavior of students and both acted immediately by quickly keeping track on the students getting only their own name tag. In the beginning it was seriously implemented but as we go along the seriousness of keeping this concern gradually declined.

b.5 Keeping students quiet during plenary

At the start of the semester both teachers got a difficulty in controlling the class particularly on the shift from the plenary to the activity and vice versa. Students tend to be noisy and chaotic during the activity which they carried during the plenary sessions. To control the behavior of these students, the teachers would not start the discussion until the students were in order and quiet. For sometime it was waste of time waiting for the students to keep quiet but then eventually the students understood that when someone was talking others would listen. This procedure was perfectly followed in the TTh group, the MWF group on the other hand failed to sustain a quiet behavior during the plenary sessions. In the interview with students (MWF group) all expressed that they were irritated by the noise of their classmates and hope that the teacher could control them.

III. April- May, 2000(Summer)

-Version 2 of the Chem 4 course material was tried out in one class with Maricel handling the course.

-20 faculty took turn in observing this class to actually see how the "scheme" is implemented. Each of the faculty observed one session per week for 6 weeks.

-Weekly discussions in both pedagogy and content were conducted.

-All teachers were involved in the revision of the version 2 and came up with the version 3. The revision was triggered by a change of textbook, but had the advantage of getting the faculty involved in choosing activities for seat and homeworks.

-Below were the schedule of activities conducted for summer:

A. 14-15 April, 2000 (Oreintation of Instructors)

Program of Activities

Day 1

1. Goals
   " Getting students to work regularly"
2. Basic Approach
   - basic rules (tardiness, textbook, notebook, assignment & checking, attendance, make- up procedure, keeping students quiet during plenary, manage disruptive behavior, get students to work immediately)
   - class meeting scheme
     plenary → exercise → closure

Day 2

1. Learning approaches: surface and deep
2. Learning process
   - orientation (prior knowledge, ability, motivation)
   - monitoring
   - interaction
3. Some ineffective practices in our class(Maricel and Dado's report of the sem 2 Chem 4 implementation
4. Course syllabus

B. Task for the week (April 17-28)

Each teacher was task to completely observe the Chem. 4 class of Maricel during their preferred day of observation. Observation was focused on the implementation of some basic concerns and the identified classroom scheme. They were also requested to assess whether these basic approaches were effective or not.

C. Tasks for the week (April 29-May 5)
a. Go over the given course material and do the following:

- decide for yourself what is the main learning target?
- are the proposed activities relevant for the main learning target? If not, propose alternative activities.
- change and modify activities for both T & S
- write detailed solution for the student activities/exercises

b. Unit Assignment for Chem 4 Course

Unit 1: Introduction Unit 2: Forms of Matter Instructors C, I, and a Ph D holder faculty	Unit 3: Atomic Structure and Periodic Table Instructors K, two other senior colleagues and the content expert observer	Unit 4: Chemical Bonds Instructors K, a senior colleague and the content expert observer
Unit 5: Chemical Equations and Stoichiometry Intructors A, D, G and O	Unit 6: Gases and Gas Laws Instructors B, F, L, M and a senior colleague	Unit 7: Energetics Instructors E, P and Q

D. May 5, 2000

The group discussed the version 2 of the Chem 4 course material. Each group presented some strengths and weaknesses of the material. The strengths include the spelling out of tasks for teacher and students, the inclusion of practical applications in most topics, and an attempt to provide a reasonable sequence of the topics. The areas in which the course material were to be improved were logical sequencing of the topics per unit, activities must be simple, direct and thought provoking. Likewise all the activities must be change to fit into the new textbook recommended by the department. Dr. Patrick John Lim, Ph D, was the content consultant for this project.

E. Tasks for the week (May 3-12)
Continue the observation still noting the basic concerns and in addition, try to go around the class during the activity and note down the following:

- whether the students start working immediately
- are the students at work? are they serious?
- listen to their conversations and look at their paper work (if any), which errors and misconceptions do you encounter?
- to what extent do students react to each other?
- difficulties in acquiring the expected knowledge & skills

F. May 12, 2000
Discussion on some poor learning tendencies

Colleagues were given a handout on some poor learning tendencies (p.179, Baird & Northfield, 1992). The list of poor learning tendencies were enumerated and discussed. The group discussion was centered on whether or not these poor learning behaviors prevailed in our classes and what had we done to address these problems. The other task for this week was to continue observing Chem 4 class focusing on the questions asked both by the teacher and the students.

G. May 19, 2000
This was the last group discussion conducted for this summer. All faculty attended the session including those newly recruited faculty. The discussion was centered on the type and level of questions asked by the teacher and the students. We also discussed some problems/difficulties we expect to encounter when implementing the model. Some suggestions to address the problems were also included.(table below). They were reminded that large class and highly heterogeneity of students in the class were the constraints that we are to contend with.

Another area of discussion was the grading system to be adopted for the coming semester. We were all convinced that assessment and evaluation is another area that we need further training and technical know how so pending an input on this area the group agreed temporarily to have the following sources of data as basis for the final grades: two long examinations, where one will be conducted before the midterm and the other after the midterm; graded activities, which are dependent on the teacher; and the final exam which is a departmental one. Furthermore the group suggested the need to have an input on the different techniques and methods of assessing and evaluating students' learning outcomes. Dr. Largo was requested to share his expertise on this area within the semester and Dr. Patrick to help us in enhancing our knowledge on atomic structure and chemical bonds. A handout on good learning behaviours by Baird & Northfield (1995) were distributed for them to read and reflect on.
Some of the difficulties experienced by the instructors are:

Problems/Difficulties	Suggested Solutions
1. heterogeneous class	-back-up questions for fast learners -peer teaching
2. plenary content	-group session -simulation lesson -provide lecture on some topics (atomic structure , chemical bonds, phase changes)
3. resources (video materials, transparencies, overhead projector)	-borrow from SMEI another set of VHS if two teachers would need them simultaneously -request for OHP to be permanently placed in each classroom -make duplicate copies of transparencies
4. chemicals for demonstration	-teachers are to prepare their own with the assistance from the Inorganic Chem lab in charge