

**A CASE STUDY OF COOPERATIVE LEARNING
IN INORGANIC CHEMISTRY TUTORIALS
AT THE VIETNAM NATIONAL UNIVERSITY - HO CHI MINH CITY**

by

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M.Sc., Comprehensive University – Ho Chi Minh City, 1996

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**A Case Study of Cooperative Learning in Inorganic Chemistry Tutorials at
the Vietnam National University - Ho Chi Minh City**

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ABSTRACT

Teaching methods in higher education in Vietnam are dominated by the lecture method. The lecture method allows students to passively receive information from teachers; it pays little attention to the processes of constructing knowledge and developing cognitive abilities of students. In this study, the investigator attempted to create a learning environment to provide conditions for students to construct their own knowledge and to develop thinking in order to help students learn more effectively. The learning environment is cooperative learning, in which students worked together in small groups to solve problems in the tutorials of an Inorganic Chemistry course. The study investigated students' behaviors when they were studying in this environment, students' beliefs about cooperative learning and their attitudes toward this learning-teaching method.

Twenty-seven students in Chemistry Department of the Natural Science University at Vietnam National University in Ho Chi Minh City participated in the study during six tutorial periods. Data were collected from observations of students' behaviors in the tutorials and interviews designed to determine students' opinions about cooperative learning. The data were analyzed and presented mainly in a descriptive style.

Findings of the study indicated that students believed that cooperative learning approaches were a valuable method for promoting their learning. Students believed that their reasoning ability was developed and their understanding of the subject matter increased when they were studying together in small groups. They liked cooperative learning and exhibited positive behaviors when studying in a cooperative learning environment.

DEDICATION

*To the memory of my Dad, my primary teacher,
who taught me to live honestly,
be aware of the beauty of life and knowledge,
love others,
and try to do something useful, no matter if small or important.*

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CHAPTER 1

INTRODUCTION

The problem

An important objective in teaching science in higher education is to enable students to acquire knowledge in order to understand the nature of the world. In contemporary perspectives on education, knowledge cannot automatically be transmitted from one person to others (see Herron, 1996). Knowledge is constructed in the mind of the learner based on existing knowledge and understanding. But most course material in science education has typically been “taught” by the lecture method (Cooper, 1995; Kolz & Snyder, 1982). In the lecture method, students go to class, listen and take notes on the lecture of the instructor. According to many educators (Kolz & Snyder, 1982), the “lecture method” is common because it is thought to be the most economical and convenient way to deliver information. The lecture has been considered to be an efficient method to present the fundamentals of science, to emphasize the key concepts and to model problem solving skills. However, the lecture method has many weaknesses in terms of the learning processes. This method often places students in the role of spectators in classes. It may be appropriate for some students, but others may feel bored because they already know what the lecturer is explaining, or they cannot keep up with the lecturer’s explanations. The lecture method allows students to passively receive information from teachers; it pays little attention to the processes of constructing knowledge and developing the cognitive abilities of students.

In Vietnam, before 1987, the national education system was organized and managed according to the principles of the central government. The main task of higher education was training manpower to fulfill goals determined by the government. With limited financial resources, the system provided only minimal support for higher education institutions. Textbooks, teaching materials, and instruments for laboratories gradually become deficient and out of date. Isolated from professional science and educational communities of the developed world, Vietnamese teachers mainly lectured in class.

The "open door" policy of the Vietnamese government in 1987 has led to many changes. There has been a shift from a central economy to a mixed economy with both socialist and market sectors. This shift has required the national education system to change also. Education and training must equip the Vietnamese citizenry with contemporary scientific and cultural knowledge and skills to meet the demands of the developing society. Higher education and training must not only acquaint students with modern science and technology but also develop their logical reasoning, abstract thought, and creative abilities. In other words, students must be trained to become independent thinkers instead of "technicians" (Ministry of Education and Training, 1995).

In higher education in Vietnam, many important changes have taken place, both in the institutions and in the curricula. In addition to the public school system, many privately funded schools have been created in the big cities to give more high school graduates opportunities to enroll in higher education. The credit system has been gradually applied in many universities to give some needed flexibility to the teaching and learning processes. Students can choose their individual plan of studying suited to their

abilities. They have chances to transfer programs when necessary, or to pursue more elective subjects helpful for their future careers. Changes in the curriculum have come very slowly. There is still a need to reorganize course content, especially in science education, to update the trends in science knowledge today. Similar to the general situation of higher education, teaching methods in science education in higher education in Vietnam are still dominated by the lecture approach. According to many Vietnamese teachers (Tertiary education system lacks quality, 1998), our students are passive in learning, their learning relies more on teachers than on themselves due to the lack of textbooks and the domination of the lecture method. The lecture method is an outdated approach, and needs to be modified.

My concerns and purpose of the study

A tradition of Vietnamese people is their eagerness for learning. In my Chemistry department, I have seen many students working hard with course materials. But their final exams reveal that some students can not express their answers clearly and logically, although the results might be right. Others are misled by minor mistakes. They seem to work hard, but do not acquire the necessary knowledge. I am very keen to facilitate students' learning, to make them actively engage in constructing their own knowledge, and to help them develop their abilities in reasoning and logical thinking. I agree with Ruggiero's statement (cited in Johnson & Johnson, 1994): "The only significant change that is required is a change in teaching methodology" (p. 58). Even though we require students to have abilities of reasoning, logical thinking, and working independently, we still mainly lecture to them. As mentioned earlier, when we lecture, we do not provide sufficient conditions for students to construct their own knowledge, to develop their

thinking. So we teachers have to change our methods because "... teaching of higher level reasoning and critical thinking does not depend on *what* is taught, but rather than on *how* it is taught" (Ruggiero, cited in Johnson & Johnson, 1994, p. 57).

Another question is, "what method will be effective for our students?" Some educators (Dressel & Marcus, 1982; Herron, 1996) believe that learning is dependent upon many factors, such as the teachers, the nature of the materials, and the characteristics of learners. Learners have very individual learning characteristics so that no structure can be equally useful to all. Teachers can facilitate learning of students with varied background and characteristics by placing them in an environment in which they must actively process information to learn. One such method involves cooperative learning.

Cooperative learning, as an instructional technique, is not new in education. It has been identified in different ways, such as small group learning, team learning, learning together, and so on. Generally, in cooperative learning, students are placed in small groups to work together to complete a structured task (Cooper, 1995). Town and Grant (1997) said, "Cooperative learning activities can create an environment in which students actively engage in the material by sharing insights, ideas, and presentation, giving feedback, and teaching each other" (p. 819). Research in teaching methods in the last 20 years indicates that cooperative learning is a fruitful instructional strategy to promote learning in many ways. Johnson and Johnson (cited in Herron, 1996) said that:

Most cooperative learning strategies require students to teach other members of the group. When students explain something to others, try to understand what others are explaining to them, and try to fit pieces of information together, they think differently than when they study alone. They used elaborative and

metacognitive strategies more frequently, and they used more higher level reasoning. (p. 55)

I have seen many students in Vietnam study together outside classes, and I have had some experience myself. Often we sit together but learn separately. We may explain things to others, but rarely share ideas or discuss together to find the solutions to problems. When I enrolled in graduate courses in SFU, I had opportunities to discuss in small group learning. I found a new breath of life. I was surprised to see that different students were interested in different aspects of a lesson. The group discussion allowed me to see the subject matter in different ways. I learned many things from my friends' concerns. Even though students from Western and Eastern cultures were expected to be different, we were sometimes similar in our thinking and opinions.

Encouraged by the idea that cooperative learning approaches would be exciting to my students, and facilitate their learning, I decided to try this strategy in the tutorials of an Inorganic Chemistry course, in the topic "Phase diagrams of solid-liquid equilibrium for aqueous solutions and inorganic salts." My assumption was that students would learn about solving chemical problems when analyzing, interpreting or seeking information in their cooperative groups. The focus of my study is to investigate attitudes of the students toward cooperative learning when they participated in this learning approach.

Although attitude is a common term in English language used to describe and explain human behaviors toward another person or an object, in social science there have been various definitions of attitude with very little overlap (Oskamp, 1991). In this study, attitude is considered as people's affective response – feelings and emotions – toward given objects.

A study of students' attitude toward cooperative learning approaches is necessary because the affective domain has important influences in the learning and achievement of students. Researchers in cooperative learning (see Slavin, 1995) found that students who preferred cooperative learning learned more in cooperative environments than those who favored competition.

Attitude of people toward an object is oriented by people's cognitive beliefs about the object, and attitude guides individual's actions toward the object (Oskamp, 1991). Cognitive beliefs are "statements indicating a person's subjective probability that an object has a particular characteristic" (Oskamp, 1991, p. 11). In other words, cognitive beliefs of people are their thoughts, or ideas about objects and events. Sometimes, the combination of attitude and beliefs is called opinions. Attitude can be inferred from people's behaviors toward the object and their beliefs about the object (Oskamp, 1991). In this study, students' beliefs about cooperative learning and their behaviors when they participated in this learning approach were considered too.

Generally, the goals of this study were to investigate:

- students' behaviors when they were studying in a cooperative learning environment,
- students' beliefs about cooperative learning, and
- students' attitudes toward cooperative learning.

Significance of the study

Because most of the science teachers in higher education in Vietnam have not been equipped with sufficient background knowledge of teaching-learning processes and teaching methods, this study introduced a model of teaching. Evidence of behaviors of our students in learning and their opinions toward cooperative learning in this study should bring insights about this teaching-learning approach in the Vietnamese context. The findings of this study may persuade our teachers to use cooperative learning methods or to seek other appropriate methods in order to alter the domination of the lecture method in higher education in Vietnam and to improve teaching-learning processes.

Structure of the thesis

The thesis is presented in five chapters. Chapter One has stated the problem, indicated the purposes of the study and discussed the justification for the study. Chapter Two reviews the literature related to cooperative learning methods. The nature, effectiveness, and trends of cooperative learning in education are presented. Chapter Three describes the study, including the context of the study, the instructional sequence, data collection procedures, and methods of data analysis. Chapter Four presents the findings of the study. Chapter Five discusses the findings and limitations of the study, and suggests implications for higher education in Vietnam.

CHAPTER 2

LITERATURE REVIEW

This chapter provides an overview of cooperative learning. But before reviewing the characteristics, effects and trends of cooperative learning, it is helpful to see it in relation to other learning approaches in schools: competitive, individualistic and cooperative learning.

Three types of student-student interaction in learning

Learning is complex. A great deal of learning takes place in schools by reading books, solving problems, discussing with teachers and peers, modeling, and so on.

Herron (1996) suggests that several factors influence learning processes, such as the nature of learning materials, of learning activities, the characteristic of evaluation, the characteristics of the learners and the teachers.

Characteristics of learning materials include the qualities of text, the level of abstraction, and the number of new ideas presented in each lesson. The nature of learning activities refers to such things as whether students work individually or in groups and whether course content is presented by lecture, direct experience, or through reading. The nature of evaluation refers to learning goals and criteria for success. Characteristics of the learners relate to their prior knowledge, social maturity, their interest and motivation in learning and in the subject matter. These factors affect each other and a change in one factor influences other factors. Central to these factors are teachers who, as instructional

designers, must be aware of the surrounding factors and “engineer” classrooms to facilitate students’ learning.

Students usually engage in learning with different levels and types of motivation (Herron, 1996; Ormrod, 1999). Some students clearly want to learn what is being presented in class. Some are more interested in pleasing their parents and teachers, getting good grades and awards, or being better than peers. Others study without consideration of possible rewards or how their performance compares to others. They are curious about task involvement, increasing knowledge and deep understanding. Therefore students’ learning activities are different, and interactions among students in learning are varied. Teachers can set learning activities to orient student-student interaction in three different ways: competition, individualization, and cooperation (Johnson & Johnson, 1994; Johnson, Johnson & Smith, 1991).

Competition

When students are in an environment in which they compete for a limited number of high grades or achieve a special goal, they work against each other (Johnson & Johnson, 1994; Johnson et al., 1991). They engage in a win-lose struggle to see who is best: my winning means you lose. Such is the nature of a competitive environment. There is a negative interdependence among students’ learning and goal achievement because students perceive that they can obtain their goals if and only if some others fail to reach their goals.

In competition, some students learn how to win, and know that a waste of time does not help them win (Johnson & Johnson, 1994). That requires them to work faster

and more accurately than others. But competitive situations lead to many drawbacks in learning. Crockenberg, Bryant and Wilce (cited in Johnson & Johnson, 1994) noted that, in most classrooms, the majority of students always lost and a few students always won. The losers in competitive situations tend to perceive their learning as boring, unfair, not interesting, and perceive themselves negatively. Competition tends to increase anxiety; and is considered a reason for cheating in class (Johnson & Johnson, 1994).

Individualism

Another type of learning environment in which students work on their own with little or no interaction with classmates is individualistic learning. This situation is achieved when a framework of individualized incentives is developed. In individualistic learning, students are asked to work individually to accomplish their own learning goals unrelated to those of other students (Johnson & Johnson, 1994; Johnson et al., 1991). Individual goals are assigned, and each student strives to achieve the preset criterion of excellence.

Individualistic learning can be structured for many lessons. But Johnson and Johnson (1994) have been concerned that individualistic learning rarely facilitates students' learning and increases students' achievement. When students are set in an individualistic environment, they have to perceive the worth of learning. "The more important and relevant students perceive the learning goal to be, the more motivated they will be to learn" (Johnson & Johnson, 1994 , p. 145). Teachers have to spend a great deal of time monitoring and assisting individual students. Otherwise, in a classroom emphasizing with individualistic efforts, students tend to work in isolation. They may

begin to compete with each other within an individualistic situation, even though it is not required.

Cooperation

In contrast to the two learning environments described above, there are situations in which intentional interactions among students are encouraged. There are environments that emphasize cooperative learning. In such situations, the students work together in small groups with help, assistance and encouragement from each other to reach the shared goals. Thus, every student has equal opportunities for success in a common criterion. Compared with competitive and individualistic situations, cooperative learning is perceived as the most powerful of the three ways to structure learning conditions:

Compared with competitive and individualistic activities, cooperative learning experiences tend to promote higher motivation to learn, produce more positive attitudes toward learning experiences and teachers, and result in stronger perceptions that students care about learning and assisting one another. (Tobin, Tippins & Gallard, 1994, p. 79)

Cooperative learning promotes students' learning and leads to higher performance (Johnson & Johnson, 1994). However, sometimes students can sit in groups without interacting, or they can interact in negative ways. (Herron, 1996). Such problems can make others think that cooperative learning is an exploitation of high ability students rather than "cooperation" (Robinson, 1990). Teachers must be trained to manage cooperative learning activities. So that cooperative, competitive, and individualistic learning are not in competition with each other. They can be used appropriately and in integrated ways to benefit individual differences and to enhance learning. In this condition, their sum is far more powerful than the separate parts. When the learning

material is simple and needed for use in the near future, individual learning can be constructive. Competition is appropriate to use when speed on a very simple task is required. Otherwise, students can be assigned to groups to learn cooperatively, compete for fun and enjoyment, and work independently on their own.

Cooperative learning and its effects on students' learning

These three types of student-student interaction have occurred in schools for hundreds of years. Most traditional classes have emphasized the role of individualism or competition. But students have also learned together. The heart of cooperation in learning is captured in an old Roman statement "Qui Docet Diset" (when you teach, you learn twice). Johann Amos Comenius (cited in Johnson & Johnson, 1994), a philosopher in the 17th century, believed that "students would benefit both by teaching and by being taught by other students" (p. 46). In the late 1700s, Joseph Lancaster and Andrew Bell made extensive use of cooperative learning in England, and this idea was brought to America when they opened a school in New York in 1806. One of the earliest successful supporters of cooperative learning in America was Colonel Francis Parker in the 19th Century. Parker brought an atmosphere that was truly cooperative and democratic into the public school. There were more than 30,000 visitors a year to examine his use of cooperative learning procedures when he taught at Quincy, Massachusetts in 1875-1880. This method spread in American education at the turn of the century. Studies in cooperative learning began. At that time, research in psychology (see Johnson & Johnson, 1994) indicated that "groups were dynamic wholes in which the interdependence among members could vary" (p. 39). However, at the beginning of the 20th century, studies shifted to the factors associated with competitive conditions.

Interpersonal competition and individualistic learning had begun to be emphasized in the public schools from the late 1930s. Studies moved to comparisons of the effectiveness between cooperation and competition.

From the middle of 1960s, modern educators have paid attention to cooperative learning (Johnson & Johnson, 1994; Slavin, 1995). Theoretical models concerning cooperative learning were formulated. A great deal of research in cooperative learning has been conducted in elementary and secondary schools from the 1970s. Some research was carried out to compare students' achievement with other instructional approaches, many others to test the models and translate them to concrete strategies and procedures for using cooperative learning. As a result, cooperative learning strategies have proliferated in the past 20 years.

Cooperative learning has changed a great deal from the beginning (Johnson & Johnson, 1994). Nowadays, many different models of cooperative learning are available for teaching all over the world. Detailed descriptions of such models can be seen in "Cooperative learning: theory, research, and practice," by Robert Slavin (1995). Millis and Cottell (1998) said that an exact definition of cooperative learning is impossible because there are so many perspectives on cooperative learning. But all cooperative learning methods share the general idea that students work together in small groups to complete joint goals.

Most cooperative learning structures today are based on a high level of positive interdependence among group members (Johnson & Johnson, 1994; Johnson et al., 1991). Members in the group are expected to be responsible not only for their own

learning but also for the learning of others. Thus, cooperative learning emphasizes joint performance. In addition, cooperative learning highlights the application of the communication skills needed for teamwork.

Johnson and Johnson (1994) reviewed thousands of studies on cooperative learning and synthesized the effects of cooperative learning on students' achievement into three categories: effort to achieve, positive interpersonal relationship and psychological adjustment.

Effort to achieve

Students in cooperative situations not only presented more persistence in continuing to learn in the subject area, but also more frequently used higher levels of reasoning and critical thinking to generate new ideas and solutions than in competitive and individualistic situations. They also produced higher comprehensive achievements, and presented more positive attitudes toward the subject area being studied.

Interpersonal relationships

Cooperative learning seemed a way to create a happy, social support environment in classes. It tended to promote greater affective perspective taking than competitive or individualistic experiences do. Social perspective taking is the ability to understand how a situation appears to another person and how that person reacts cognitively and emotionally to the situation. In other words, a person with social perspective taking can understand the viewpoints of others. So students experienced with cooperative learning usually have better relationships with classmates.

Psychological adjustment

The most important psychological outcome of cooperative learning methods is their effect on students' self-esteem. Although it hardly seems that a cooperative learning experience, typically in one class for a few weeks or months, would fundamentally change students' self-esteem (Slavin, 1995), two components of students' self-esteem in cooperative learning were reported: (1) students believed that they were liked by peers and that others saw them in a positive way, and (2) students felt self-confident about their knowledge and they did well in academic tasks. Otherwise, cooperative learning positively affected other psychological characteristics of students, such as emotional maturity, strong personal identity, and basic trust in other people.

However, not all studies have determined that cooperative learning approaches resulted in higher academic achievement than other forms of instruction. Johnson and Johnson (1994) claimed that it was not easy to compare the effectiveness of cooperative learning methods to others because many studies of cooperative learning were mixed with other kinds of instruction. Slavin (1995) carefully reviewed 99 experimental research of cooperative learning in different models in elementary and secondary schools. Designs of the reviewed studies had to meet four criteria: (1) the experimental and control groups showed equivalence in initial academic achievement, (2) the treatment time was at least four weeks, (3) the experiment and control groups studied the same materials, and (4) the achievement test assessed the objectives taught in both experiment and control groups. The results noted that only 64% of the studies found cooperative learning instruction had positive effects on students' achievement, while 31% found no difference and 5% found significant differences in favor of control group. Therefore

educators have not only considered the effects of cooperative learning on students' achievement but also have investigated the conditions in which it has led to positive results. The factors that contribute to the effectiveness of cooperative learning will be discussed in the following section.

Factors affecting the results of cooperative learning

In the reviewed research of Slavin (1995) just mentioned above, the author compared student achievement of cooperative learning with group goals based on individual accountability, with group goals only, with individual accountability only, and without group goals or individual accountability. In methods with group goals based on individual accountability, all members in the groups received group scores or group rewards based on individual efforts. Group scores were the average of individual scores of the group members when group members could not help each other on the individual tests; or a group member might be chosen randomly to present the group's conclusion, and all group members received the scores based on the grade of the selected member. In contrast, in the methods lacking group goals, students were given only individual grades or feedback, there was no consequence for doing well as a group. In the methods lacking individual accountability, all group members received the same grade on a single project or worksheet for the group. The results revealed that cooperative learning with group goals based on individual accountability had the greatest effectiveness on students' achievement.

Slavin (1995) indicated that students could be taught strategies and communication skills for cooperative learning that led to higher achievement without the

need for group rewards. He also claimed that a combination of group rewards and teaching cooperative learning strategies led to better outcomes than group rewards or teaching strategies alone.

In a different way, Johnson and coworkers (see Johnson & Johnson, 1994; Johnson et al., 1991) interviewed thousands of students and teachers in a wide variety of cooperative learning environments to discover how cooperative learning worked best. The results were stated in terms of five basic elements of cooperative learning:

(1) Positive interdependence between group members:

With Johnson and coworkers, positive interdependence between group members is "the heart of cooperative learning" (Johnson & Johnson, 1994, p. 23). Positive interdependence has been successfully constructed when members in the small groups perceive that "they are linked with each other in a way that one cannot succeed unless everyone succeeds" (Johnson & Johnson, 1994, p. 22). It requires all members in the group to encourage each other to make maximum efforts to learn.

Positive interdependence can be structured by setting common criteria for groups' success, then each group member receives the same rewards or bonus points in their academic scores when everyone in the group achieves up to the criteria.

(2) Individual accountability:

The purpose of cooperative learning is to make each member in the group learn more effectively. Individual accountability is the key to ensure that all group members work realistically in cooperative learning situations. Individual accountability exists when

students have responsibility for their performance. This requires students learn together and demonstrate their learning independently.

(3) Face-to-face promotive interaction:

Promoting face-to-face interaction among group members is essential in using cooperative learning (Johnson & Johnson, 1994). "Promotive interaction exists when individuals encourage and facilitate each other's efforts to complete tasks in order to reach the group's goals" (p. 89). Members in the group can facilitate other's learning by explaining how to solve problems, discussing the nature of concepts being learned, teaching one's knowledge to group-mates or connecting present knowledge with the past. Johnson and Johnson (1994) said that monitoring groups and celebrating promotive interaction of the group's members was a way to promote face-to-face promotive interaction.

(4) Interpersonal skills:

Because people are not born naturally knowing how to interact effectively with others and interpersonal skills do not magically appear when necessary, students must be taught skills required for quality interaction: They must learn to know and trust each other, to communicate accurately and unambiguously, to accept and support each other and to resolve conflicts. Johnson and Johnson (1994) noted that, "The more socially skillful students are, the higher the achievement that can be expected within cooperative learning groups" (p. 90).

(5) Group processing:

Group processing exists when group members discuss how well they are achieving their goals, and indicate what behaviors are helpful or have to change to make the group work better. In addition, teachers need to monitor group work, to support feedback and intervene when necessary to help groups work effectively.

It is easy to recognize that the factors stated by Slavin and by Johnson and coworkers above have some similarity. This similarity strengthens the notion that building positive interdependence and individual accountability and monitoring the processes of applying cooperative learning skills are important for getting positive results in students' learning.

Beyond these essential factors, some studies have examined additional aspects that might relate to students' achievement in cooperative learning methods. A concern is whether homogeneous or heterogeneous groups in terms of students' academic ability increase their performance. Moody and Gifford (cited in Slavin, 1995) found that there were no differences in performance of homogeneous and heterogeneous groups. But from observations of students' learning in groups, many teachers and researchers (e.g, Johnson et al., 1991; Slavin, 1995) highlighted the benefits of heterogeneous groups. Johnson et al. (1991) identified that:

More elaborative thinking, more frequent giving and receiving of explanations, and greater perspective taking in discussing material seems to occur in heterogeneous groups, all of which increase the depth of understanding, the quality of reasoning, and the accuracy of long-term retention. (p. 4:6)

Evidence from Tingle and Good's study (1990) showed that, if all group members were weak in knowledge, no student knew how to solve the problems in the tasks. Consequently, they were unable to work together to solve the problems. Johnson and Johnson (1994) noticed that a force might hinder groups' performance was the insufficient heterogeneity in the groups: "the more homogeneous the group members, the less each member adds to the group's resources" (p. 78). In contrast, some teachers (see Ormrod, 1999) said that a problem in heterogeneous groups was high ability students were apt to dominate group, while low ability students might be reluctant to ask for help, or they might let other group members do most of tasks. Robinson (1990) considered that "talented students" would have no time "to learn anything new to them" when they spent "the majority of their school day" to study in cooperative learning groups (p. 19). In order to reduce these disadvantages of heterogeneous groups, many researchers (e.g., Johnson & Johnson, 1994; Slavin, 1995) suggested students had to be taught necessary skills for teamwork; group goals based on individual accountability were means to avoid the domination or "hitch-hiker" phenomenon in the groups. Otherwise, teachers must monitor and intervene in group learning when necessary. The problems considered by Ormrod and Robinson seem to be soluble. Now many teachers and researchers (e.g., Cooper, 1995; Herron, 1996; Johnson et al., 1991; Slavin, 1995) agree that groups should be heterogeneous in terms of students' abilities. Tingle and Good (1990) and Slavin (1995) suggested that students' academic performance was a good criterion for assigning students in heterogeneous groups.

The rich history of theory, research and practice of cooperative learning methods informs us about how students learn in groups. Theory both guides research and helps to

interpret what research and practice investigate. Further, research and practice may consolidate or revise the theory. Therefore it is of interest to review what theorists have said about the dynamics of cooperative learning.

Theoretical framework of cooperative learning

There are many theoretical perspectives related to cooperative learning. Slavin (1995) suggests that these theories can be classified into two major categories: cognitive theories and motivation theories.

Cognitive theories

Several cognitive theories have been proposed to explain cooperative learning. They fall into two groups: development theory and elaboration theory.

1. Cognitive development theory:

Both Vygotsky's theory and Piaget's theory provide justifications for cooperative learning. According to Vygotsky's theory of cognitive development (Vygotsky, 1934/1978), the processes of cognitive development can operate only when a person interacts with others in his environment. A person's cognitive development is most promoted and enhanced when he/she works in tasks within his/her "zone of proximal development" through interaction with more capable individuals. Vygotsky defines the zone of proximal development as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86).

Clearly, learning in cooperative conditions takes place in an environment of social interaction. When students work cooperatively within their zone of proximal development, members with higher capability in heterogeneous groups can supply “scaffolding” to members with lower capability to move into a zone of proximal development. Scaffolding is a term used to describe the role of a tutor in enabling a child or a novice to solve a problem that is beyond his individual efforts. Scaffolding is “the process of controlling the task elements that initially are beyond the learner’s capacity, so that the learner can concentrate on and complete those elements within his or her immediate capacity” (Gredler, 1992, p. 288). Therefore when students study cooperatively in heterogeneous groups, their knowledge can be developed, clarified and refined through the scaffolding of their group-mates (Towns & Grand, 1997).

According to Piaget’s theory of cognitive development (cited in Ormrod, 1999), people sometimes can explain new information in terms of their existing knowledge. But sometimes they cannot explain new experiences in terms of their current understanding. Such inexplicable events create “disequilibrium.” Only through reorganizing or replacing their knowledge can disequilibrium be resolved, and people become able to understand and explain the new events. The process of moving from equilibrium to disequilibrium and to new equilibrium is known as equilibration, which promotes cognitive development. For Piaget (cited in Gredler, 1992; Ormrod, 1999), interactions with physical and social environments are factors influencing humans’ cognitive development. People discover their perspective of the world through both conversations and conflicts over the issues they are discussing.

In cooperative learning when students discuss subject matter together, cognitive conflicts sometimes arise, inadequate reasoning is exposed, students move in equilibration processes, and higher quality of understandings emerge (Slavin, 1995). On these grounds, educators (see Slavin, 1995) have called for an increased use of cooperative activities in schools.

2. Cognitive elaboration theory:

Research in cognitive psychology (see Slavin, 1995) has found that if information is to be retained in memory and related to existing knowledge, learners must engage in some sort of active cognitive construction or elaboration of materials. Many researchers (see Herron, 1996; Ormrod, 1999; Slavin, 1995) have found that, when students study in cooperative learning environments, they have to explain things to others. They use greater comprehension and elaboration of the subject matter. They also co-construct their ideas and use metacognitive strategies more frequently than when they study alone. Such activities make students learn more effectively. Slavin (1995) also claimed that students who provided elaborated explanations to others gained the most in cooperative learning.

Motivation theories

People are always motivated in some activities by one reason or another.

Motivation is an internal state that arouses us to action, pushes us in particular directions, and keeps us engaged in certain activities (Ormrod, 1999; Pintrich & Schunk, 1996). The motivational systems promoting learning within cooperative environments include extrinsic motivation and intrinsic motivation.

1. Extrinsic motivation:

Extrinsic motivation exists when the source of motivation lies outside of the individual and the task being performed (Ormrod, 1999; Pintrich & Schunk, 1996). When motivated extrinsically, individuals work on tasks because they believe that the participation will result in desirable outcomes such as a reward, teacher praise and so on.

According to Slavin (1995), motivation perspectives of cooperative learning basically focus on group goals and group rewards. This is extrinsic motivation. Group goals and group rewards are the primary forces to build positive interdependence among group members, in which the only way for the group members to attain their own personal goals is the success of the group. Therefore, to meet their personal goals, the group members must help and encourage their group-mates to exert maximum effort in learning.

2. Intrinsic motivation:

Intrinsic motivation exists when the source of motivation lies within the individual and task; the individual engages in activity for its own sake (Ormrod, 1999; Pintrich & Schunk, 1996). People who are motivated intrinsically work on tasks because they find the task enjoyable and worthwhile.

Johnson and co-workers (Johnson & Johnson, 1994; Johnson et al., 1991) note another form of motivational system promoting learning within cooperative learning situations is intrinsic motivation. When cooperative learning situations are structured well, the class usually has a positive emotional climate in which the students are willing

to take on tasks with greater social support, such as assistance, encouragement and caring. Such components have effectiveness on students' learning. Students' understandings of subject matter increase, they feel more confident about their knowledge. They develop more positive attitudes toward learning and perceive their learning as interesting, which increases their intrinsic motivation to learn. These factors affect each other and promote learning.

With a strong foundation of theory and research, many researchers in cooperative learning have gained great experiences in structuring cooperative classes. For teachers who are beginning to try cooperative learning strategies, many worthy guides can be found in the literature, such as, "Active learning: cooperation in the college classroom" (Johnson et al., 1991), or "Learning together and alone" (Johnson & Johnson, 1994). These publications discuss the factors that can hinder group achievement, the interaction skills that must be taught to students, and the ways to reduce problem behaviors. In the rest of this chapter, I will review literature about cooperative learning methods in teaching chemistry in higher education.

Cooperative learning in teaching chemistry in higher education

There have been many arguments for using cooperative learning in higher education. Tribe (1994) investigated the reasons why some teachers in higher education hesitated to utilize cooperative learning. Some faculty members felt that the time for group work would be a sacrifice because the class could not cover the syllabus fully other than by formal lecture. But now the concept of "full syllabus coverage" seems to be outdated. The emphasis in higher education is now on the formation of reasoning and

logical thinking, rather than any specific content. Another argument is that teachers and students alike are not familiar with classroom environments that are not teacher-centered. In practice, however, most students and teachers quickly recognize the advantages of cooperative learning approaches and have become satisfied in cooperative learning environments (Tribe, 1994). But a certain problem in higher education is that lecturing staffs have not received enough training for their role and skills to set up cooperative learning activities:

There are many factors supporting the use of cooperative learning in higher education (Millis & Cottell, 1998; Tribe, 1994). The new paradigm in teaching science in higher education today emphasizes that students must "construct" their knowledge for themselves:

A college's purpose is not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge for themselves, to make students members of communities of learners that make discoveries and solve problems. (Millis & Cottell, 1998, p. 23)

There is much support for the idea that small group learning assists students to discover and build up their knowledge themselves (Michaelsen, 1994; Slavin, 1995). Cooperative learning also provides a sound basis for developing mutual respect, interpersonal communication, conflict resolution and group decision making skills required for success in students' future careers and lives (Michaelsen, 1994; Millis & Cottell, 1998).

Gradually, cooperative learning has gained more and more interest and acceptance in higher education (Cooper, 1995; Kerns, 1996; Millis & Cottell, 1998). But research in cooperative learning in science in higher education was not conducted until

the 1990s. In 1994, Michaelsen reviewed the use of cooperative learning in higher education and said that it was "still much more of a novelty than a common practice" (p. 139). The most popular uses of cooperative learning are: (1) forming temporary groups in which students are asked to talk about a specific issue as a precursor to a class discussion and (2) assigning a group project with little or no class time devoted to group work. The problem of temporary groups is the limited degree of commitment due to the novelty of the group. When students spend time working out side of class, they encounter serious problems related to scheduling difficulties and workload.

Many techniques for cooperative learning have been utilized in teaching chemistry in higher education. Smith, Hinckley and Volk (1991) conducted an experimental study to test the effectiveness of a cooperative learning technique termed "Jigsaw" in a laboratory course. This technique involves a "division of tasks so that each student in a group is assigned a particular part of a lesson or unit and acts as a resource, helping the other members of the group learn that section of the material" (p. 413). The results established that students in the experimental group engaged in cooperative learning had significantly higher grades than students in the control group.

Basili and Sanford (1991) used cooperative learning in problem solving focused on concepts in chemistry. They found that students who engaged in conceptual tasks in cooperative learning had a lower proportion of misconceptions than of students in the control group. Deeply examining students' verbal behaviors when they were studying in small groups, the authors indicated that students in the groups with more interaction and mutual help made more conceptual changes than students in groups with less interaction.

Dinan and Frydrychowski (1995) applied team learning (joining cooperative learning, testing, and feedback) to cover course content in an organic chemistry course. The authors found that students who studied in team learning environment had significantly higher mean scores in the final exam than students who had been taught by the lecture method in three prior years. They noticed that in the team learning method, course content was covered much more than in lecture method. Students in the study reported that team learning was an effective way to learn organic chemistry, team learning built better relationships among students than lecture method, and they felt responsible for their learning and team tasks.

Wright (1996) used a series of cooperative activities outside class to move students out of passive learning. For example, cooperative take-home-exams permit students to discuss problems together but their answers must be their own, or students work together in small groups over a long-term to accomplish open-ended laboratory projects. The question about whether students moved to active learning was not answered in the study. But students reported that group work increased their understanding of the subject matter, and they enjoyed the format of cooperative learning more than traditional learning methods.

In contrast with Wright (1996), Towns and Grant (1997) devoted time for small group discussions and presentations in a graduate physical chemistry course. They found that cooperative learning moved students from rote learning strategies towards more meaningful learning strategies involving active learning and integrated thinking. Students in the study reported that they spent more time studying and studied more frequently, and

that they had opportunities to develop their communication skills and build better relationships with peers through cooperative learning.

Generally, the effectiveness of cooperative learning in higher education in chemistry was found to be similar to applications of cooperative learning techniques in elementary and secondary schools. However, cooperative learning in higher education has appeared differently from the strategies used in elementary and secondary schools. While group scores or group rewards based on individual performances were emphasized in cooperative learning in elementary and secondary schools, group work in higher education required more individual accountability. In the five reports concerning chemistry education cited above, Wright (1996) used group projects in which each group handed in a single report and was scored as a group; Smith et al. (1991) used the average score of the group members to build interdependence among members in the group. The others either did not give a grade for group learning (Towns & Grant, 1997) or used peer grading processes (Basili & Sandford, 1991; Dinan & Frydrychowski, 1995) in which members in the group scored each other on preparation tasks and helpful behaviors to stimulate students learning and mutual help among group members.

There are many reasons for the differences. Some teachers in higher education (see Millis & Cottell, 1998) argued that the purpose of grading was to indicate students' mastery of a given subject. When grades are used for other reasons, such as to motivate or communicate with students, grades lose their meaning. Otherwise, most students in higher education were accustomed to individualistic and competitive environments. It seems easier for students in higher education to accept cooperative learning conditions when they are assured that "... their final course grades will be based on their own

efforts, uncompromised and uncomplicated by achievement of others" (Millis & Cottell, 1998, p. 12).

The question of how to evaluate students in cooperative learning environments has produced anxiety and uncertainty. Millis and Cottell (1998) said that, "much of the debate centers on the question of whether students are intrinsically or extrinsically motivated" (p. 12). Teachers have supported the role of intrinsic motivation: "Many of extrinsic motivators, not unexpectedly, are grade-related" (Millis & Cottell, 1998, p. 190). Forsyth and McMillan (cited in Millis & Cottell, 1998) suggested that students' motivation could be affected by classroom structure that capitalized on intrinsic motivation and avoided extrinsic motivators. Kohn (cited in Millis & Cottell, 1998) argued that rewarding students by putting a price tag on their efforts undermined the altruistic desire to help them.

No easy solution exists, but the real effectiveness of cooperative learning cannot be denied. It is the main reason to stimulate application of this learning approach in higher education. The next chapter will describe what happened to the Vietnamese students in an undergraduate class where cooperative learning approaches were investigated.

CHAPTER 3

DESCRIPTION OF THE STUDY

The initial part of this chapter describes the context in which the study was conducted. The students who participated in the study are introduced. Following that, the processes that occurred during the study are discussed, together with the methods of data collection and analysis.

Context of the study

The study was conducted in the first semester of the 1998-1999 academic year in a fourth-year class in the Chemistry Department of the Natural Science University, of the Vietnam National University - Ho Chi Minh City.

The credit system was adopted in the Natural Science University in 1994. At that time, the school was named the Comprehensive University - Ho Chi Minh City. In 1996, the Vietnam National University - Ho Chi Minh City was created. The undergraduate programs of the Natural Science University were constructed into two stages, as was the case with the other universities in the Vietnam National University - Ho Chi Minh City. After passing the "entrance exam," students enroll in the first stage of general studies. The first phase consists of basic and elective courses required for the subject students choose in the next stage. Students have to perform satisfactorily in at least 90 credits in three or four semesters to take the Certificate of General Program in order to transfer to the second stage. The second stage consists of five semesters requiring at least 120

credits in specified courses focused on the subject area. Students receive the Bachelor of Science degree after completing their studies.

Chemistry is a subject area in the Natural Science University. After taking some required chemistry courses in the second stage of the undergraduate program, Chemistry students can choose courses focused on one of four specialties: Inorganic Chemistry, Analytical Chemistry, Physical Chemistry and Organic Chemistry. Chemistry courses in the school have been taught in two main styles: lecture for theories and problem solving, and practice in the laboratory. The labs and theories were usually introduced in separate courses. Few courses had a textbook or syllabus.

The academic year at the Natural Science University is divided into two semesters: Semester I, from September to January, and Semester II, from February to June. Students register courses at the beginning of each semester, but their attendance in lectures is not strictly required. Midterm exams are rarely used and accounted for in lecture courses, and final exams are considered to be the formal measurement of students' achievement.

The course's structure and usual teaching-learning strategies

The topic "Phase diagrams of solid-liquid equilibrium for aqueous solutions and inorganic salts" has been taught as an advanced and elective course for senior chemistry students in the Inorganic Chemistry specialty of the undergraduate program. This is a special topic following the course "Phase diagrams."

The aim of the course "Phase diagrams of solid-liquid equilibrium for aqueous solutions and inorganic salts" was to provide opportunity for students to use phase diagrams and the phase rule to explore the processes of dissolution and crystallization of inorganic salts in aqueous solutions. The course consisted of five units as follows:

Unit 1: Basic terms and concepts. Phase rule in solid-liquid equilibrium.

Unit 2: Two-component systems: water and a salt.

Unit 3: Three-component systems: water and two salts with a common ion.

Unit 4: Non-interaction four-component systems: water and three salts with a common ion.

Unit 5: Reciprocal four-component systems: water and a reciprocal salt pair.

In the first unit, students reviewed the basic terms and concepts of phase diagrams. This review emphasized the isobaric property of solid-liquid equilibrium in the processes of dissolution and crystallization of salts in aqueous solutions. In subsequent units, students were gradually acquainted with different systems: binary systems with a simple eutectic point, with congruent or incongruent melting hydrate compounds; ternary and quaternary systems with simple salts only, with hydrous and anhydrous double salts being congruently soluble or incongruently soluble. Eutectic and peritectic processes were distinguished. The temperature-concentration diagrams for binary systems, the isotherm diagrams of concentrations for ternary systems and the isotherm orthogonal projection diagrams of concentrations for quaternary systems were used to investigate the processes of isothermal evaporation and cooling of aqueous - salt solutions. Students also

had opportunities to study the processes of separating a mixture by a temperature cycle of crystallization.

This course was taught in the first semester of the academic year. Students who enrolled in this course were supposed to take the course "Phase diagrams" taught in the semester before as a prerequisite. This course consisted of two credits (30 academic hours) for the lecture and tutorial. No lab was provided. In many years, this course had no syllabus or textbook. Students went to class to listen and take notes from the lectures. They were tutored for problem solving focusing on the course content only just before the course ended. The teacher also recommended that students should solve the problems prior the tutorials, but they hardly did so. In the tutorials, the instructor or some volunteer students solved the problems on the board while others took notes on the solutions. No midterm exam was given. In the end, students wrote the final exam, which required effective application of the knowledge studied in the course.

The students

There were 27 students, 11 females and 16 males ranging in age from 20 to 23, enrolled in the course "Phase diagrams of solid-liquid equilibrium for aqueous solutions and inorganic salts" in September, 1998 at the Natural Science University. Twenty-two of them sufficiently passed the course "Phase diagrams" in the semester before. The rest scored "below average," two of these students took the course in this study as audits. These students must rewrite the examination of "Phase diagrams" in the next semester before they can graduate. The students in the class registered for 30 credits or more in

that semester. Most of them have studied together for three years, and they knew each other well.

The teachers

The main teacher of the course "Phase diagrams of solid-liquid equilibrium for aqueous solutions and inorganic salts" was also the instructor of the course "Phase diagrams." He has had more than 15-year experience in teaching the course "Phase diagram." The topic "Phase diagrams of solid-liquid equilibrium for aqueous solutions and inorganic salts" has been taught as a separate topic in undergraduate program for four years. The instructor delivered the lectures, wrote all the questions used in the tutorials and evaluated students in the final exam. He also taught some other courses for the third year Chemistry students. So he already knew the students in this study. In the tutorials, the main instructor presented in the class to observe the activities. Sometimes he took part in the class activities, too.

The investigator took the role of the tutorial teacher in the study. She organized the activities in the tutorials and was responsible to resolve students' confusions in the problem solving. In contrast with the main instructor, this was the first time she tutored students in this course, and she did not have any relationship with the students before the study.

Overview of the study

With the usual teaching and learning style of the course described earlier, it was difficult for students to construct their own knowledge to reach intended objectives.

Cooperative learning strategies with small group discussion about the problems aim to provide conditions for students to learn more effectively.

The preparations

The primary reason I chose this course for my study was that, for many years I had heard from students that this course was difficult, and I would see students teach each other outside class just before the final exam. I thought it was helpful for all of them to have opportunities to teach and learn themselves from the beginning of the course.

Furthermore, it was an elective course; if any student did not like the activities announced in the beginning, he/she could choose another course to get credits. Another convenience was that there were not too many students in the classes of the specialty courses. Being the first time I tried the cooperative learning approach, I thought, it might be easier for me to monitor and intervene in the group learning with a small class with limited number of groups. In addition, the schedule of the course was suitable for the time I conducted my study.

I decided to talk with the instructor about the cooperative learning approach and my study. I asked him if I might try this learning approach in the tutorials of his course. The instructor was excited by my general goal to teach students more effectively, and to encourage them to learn more actively and realistically. He supported the perspectives of the cognitive theorists mentioned in the previous chapter, and agreed to make changes in his course.

The instructor wrote out all the lectures and the related problems. Those would be typed and photocopied for students before the lectures. The questions and problems used

for tutorials in this study are provided in Appendix A. The instructor also rearranged the content of the course so that each lecture could be followed by a tutorial. The first tutorial would be scheduled one week after the lecture to allow sufficient time for students to prepare the answers for the problems before the tutorial. In this way students could have opportunities to review the information that they would have already known before continuing with new information.

The course was scheduled for three academic hours a week in the very early morning, from 6:45 to 9:10 a.m., in ten weeks. The instructor noticed that students hardly went to class at such an early hour. So it was decided to arrange the tutorials in the second part of classes after the lectures (refer to Appendix B to see the schedule of classes).

When planning for cooperative learning activities, I intended to apply "peer evaluation," mentioned in the literature review, in order to stimulate students' learning. But when I expressed my suggestion with the instructor, his question was whether students were promoted by the benefits of cooperative learning itself or by "the pushing of teachers." I confirmed that the cooperative learning approach included both of them, and explained the differences of students in their motivation to learn. This reasoning was quite new for the instructor. He appeared hesitant to use grades for a purpose different from evaluating students' mastery of the subject. I really understood his concern. Those activities were too strange for our teachers and students. We need time to become familiar with and to accept different aspects of cooperative learning approaches. As Johnson, Johnson and Smith (1991) told a story about a frog; if we placed the frog into boiling water, it would immediately jump out with little damage to itself. But if we

placed it in a pot of cold water, and slowly raised the temperature, the frog would adapt to the situation. I decided to try cooperative learning in which students would work without extrinsic reasons.

The first class met on Thursday, September 17, 1998. The instructor gave the photocopied lectures to the students, and the lecture began with the first unit. After the lecture, the instructor showed the "teaching schedule" (Appendix B) to the students and introduced the investigator as their tutorial instructor.

I asked the students if they had ever the opportunity to learn with peers and introduced my study (Appendix C). The class became very excited. The leader of the class said that in the previous semester they had been given about fifty problems and questions in the course "Aqueous Chemistry." Their class was divided into three groups with nine or ten students in each group. The students in each group took responsibility for finding the answers to the given problems. Then the group met and shared the answers together. Most of the students agreed that those activities were very helpful and they welcomed another chance to work together in this way.

When I described my plan to organize heterogeneous groups of four or five students, with every student responsible to prepare for the group work by developing his/her own answers for every problem, many suggestions were proposed. Some students asked whether we could construct bigger groups, with six or seven members. Others expressed their desire to divide tasks for group members in order to lighten their work at home. I asked the students what their goals were, and declared the interrelated and continuous characteristics of the problems in this course and the need for preparing all the

answers before going to the tutorials. I spelled out the advantage of "small groups" to be that all members could participate in the group activities, and I gave them the guidance for skills necessary for learning in the group (Appendix D), and highlighted the benefits of the learning approach with students of high and low ability (Slavin, 1995). We agreed to try these strategies in six tutorial periods before making another decision.

I was encouraged by the enthusiasm of the students. Since my first thoughts about this project, however, I wondered whether the students would be satisfied working with their peers. Many teachers with cooperative learning experiences (see Woo, 1991) said that it was easy for students to work with ones they liked to. But Slavin (1995) recommended "... do not let students choose their own teams, because they will tend to choose others like themselves" (p. 74). I hoped the students would be interested in the project when they had opportunities to participate in the decisions. I asked them whether they could choose heterogeneous groups themselves. The students appeared uncertain. Some of them passed the right to create groups to their tutorial teacher. Others wanted to choose their groups but did not know how to do so. When I suggested that I divided them into four sets consistent with their grades in the "Phase diagrams" course, the course directly related to this course, and they would try to choose their groups from students in each set, the students approved the recommended processes.

There were 25 students in the class that day. All of them eagerly enrolled in the study. I checked the students on a class list in which their grades had been already ranked from highest to lowest. Four sets of students, A (the highest grades), B, C, and D (the lowest grades) with six students each set, except set B with seven, were written out on the

board. So there would be five groups with four students each, and one group with five students.

The students were also told that this arrangement was based on their performances in only one course; they were not to be judged from the range. After the list was completed, four names of members of the first group were immediately brought to the board. According to my list, this first group consisted of one A, two B and one C student. These students said that they had studied together so they wanted to continue in a group. While other students were discussing, I suggested the first group invite a D student, and encouraged the others to choose groups with a balance of males and females. The atmosphere of the class was very excited. Students posted the name of each member of their groups on the board, discussed together and made changes. In 15 minutes, the five groups had their members' names on the board. It seemed difficult to create the fifth group, and the area of Group 6 was still empty. I nudged the students to the last group. A male student posted names of the rest into the sixth group, and asked if it was convenient for everyone. Two students in one of the other groups exchanged their names with two in the sixth group. Thus, six heterogeneous groups were created. Most of the students appeared satisfied, but I was disappointed that not all of the students had their choice in forming the groups.

On the second day of the class (September 24, 1998), there were two other students attending the class. They were invited to choose a group. One joined in the Group 3 and the other in Group 5. There were three groups with four students and three groups with five students in the study (Appendix E).

The cooperative learning sequence

The intention here is not to report all the events that happened on each day in the tutorials. The following is a brief description of the important events in the class and in my field notes. The purpose is to provide readers with an understanding of students' responses to the cooperative learning tutorial.

As described above, the 60-minute tutorials were conducted weekly after the lectures. In the tutorials, students worked in the small groups about 50 minutes to discuss the solutions to the problems assigned by the lecturer in the previous lesson. Teachers observed the group work and intervened when required. After that the class met together to check the answers and explain any remaining confusion.

September 24, 1998

The first tutorial section began with 25 students (two were absent and two just signed up). Students in the groups left their places, sat face-to-face in each group around a table. The classroom was big because it was required for the study. Each group occupied a separate place and worked by themselves. The tables were small and inconvenient for four or five people to display all their documents with others; the tables were only large enough to share ideas on one or two papers.

I wanted to videotape the group work of students. But when I asked them on the first day, they appeared reluctant. I thought they would become gradually comfortable with my observations, and that maybe they would agree to be videotaped in a subsequent session. On that day I observed and made field notes of students' activities in a randomly

chosen group, Group 4. Their interactions were surprising for me. Many questions and answers related to the problems were presented quickly. The students clearly sought the reasoning behind the answers. There was not an actual leader in the group. But members in the group encouraged each other to take turns showing their opinions. They also checked each other's understanding. My observation of Group 4 was sometimes interrupted because other groups required me to resolve their disagreements. At the end of the group discussion period, I asked members of Group 4 to let me videotape their work in the next period and they agreed with little hesitation.

Most groups worked energetically. Many new questions were posed and required teachers' scaffolding. The instructor resolved some students' questions in order to let me take field notes. He was busy too. Group 6 finished their discussion in 25 minutes, separated out and joined different groups while other groups kept working. The group discussions closed for the class conversation. Some students actively presented their unsolved problems, others shared their group's opinions to resolve their peers' confusions. I felt this first session had gone well. On the way back to our office, the instructor told me that he felt the students really engaged in seeking reasoned information. The atmosphere in the tutorial was totally different from the quiet and passive one of the lecture.

October 2, 1998

We had to change the schedule on the second day because the instructor had a meeting on Thursday, October 1st. Although the change was announced in the class before, only 18 students attended the second tutorial. I intended to observe the activities

of Group 6. But only two members were present. I asked them to work with one person present from Group 5. The "new group" worked reluctantly.

The problems for the second tutorial required more mathematics. In Group 2, a male student initially acted as a leader to check the results of members in the group. He paid little attention to the reasoning of the problems and sometimes moved to the next question while some group-mates were still waiting for more explanation. But other members in the group sought reasoned answers by insistently posing questions, and it became difficult to distinguish a leader in the group. The group worked well, sharing ideas and strategies, and comparing their strategies to find the best way. Most of time they worked as group of four, but sometimes they worked as pairs. Once they confronted a difficulty, and a member proposed a solution. The group agreed on the solution with little confidence. They asked me about their answer, but I encouraged them to look for a rationale for their solution themselves. They could do this, but they still wanted to know the "exact" solution.

At the time for the large group gathering, Group 1 and Group 2 were invited to share their results. Both groups sent male students to present in front the class. Many students required displaying the whole solution because each of them got different results. After that the reasons for the differences in results were discussed and the tutorial concluded with the instructor's explanation. He emphasized the importance of understanding characteristics of the crystallization processes, but reducing the calculating processes. He also suggested that I would answer the remaining questions but not let the students present all the answers because it took much time and was unnecessary.

October 8, 1998

The class was full again with 25 students. I anxiously wanted to know how Group 5 and Group 6 worked since some students missed the second tutorial. I observed Group 6 since Group 5 agreed to be videotaped.

Initially, four members of Group 6 sat together, but only two students worked cooperatively. The others were absent from the previous class and did not prepare sufficiently for the work group. One student read his notes, while the other listened to the dialogue of his team. I suggested the team focus on a common problem and share resources. The four people started to work together. Sometimes the group members asked each other if they could understand the solutions, but the two "unprepared" members really participated in the group work when they asked for more explanation. The other group members offered explanations again in the group or sometimes in pairs. This group worked more slowly than the other groups.

The videotape of Group 5 revealed that, although only one student was present in the prior class, three others prepared solutions to the problems and engaged suitably in the group work. The student who did not prepare the problems in advance stayed by his group-mates and listened when peers shared ideas and checked their results. He began to take part into the group discussion when he posed questions himself. It seemed that preparation of a solution strongly affected the students participation in the group learning. This group also spent much time working in pairs. When one student presented a difficult solution, others listened carefully and asked immediately when they needed more explanation. The presenter also checked his peers' understanding before continuing. In

this group, no one reminded others to engage in the group discussion, but all members, no matter if they were high or low ability, appeared ready to share their understanding when their peers required it.

There were many tasks for students in that period. The students could not deal with all the problems in the group work. The instructor declared that it was not necessary to solve all problems in his lecture handout. Each group focused on different problems. The groups were working eagerly. I did not have enough time to visit and intervene in every group except when they required. But I recognized, here and there, when a student seemed isolated while his/her group-mates discussed energetically. I expressed my concern that some students did not really participate and learn in the group work to the instructor. He said, regardless of the learning environment, we could not expect everyone to work well at the same level, but most students actually studied well in the group work. It was really appropriate.

October 12, 1998

Because the instructor had regular meetings on Thursday mornings, the weekly class time for the course was changed to Monday mornings. Twenty-four students attended the class on Monday, October 12. We had a smaller room, which was less suitable because of the noise around the groups.

In Group 3, a female student took the role of leader. She eagerly presented her solution to the group-mates at a fairly quick speed, and did not pay attention to the problem of how her group-mates received the information. The other students frequently posed questions to make her explain the solution more clearly, or gave their opinions to

correct her mistakes. Members in the group sought the reasoning behind the solutions and judged the answers fairly, but the atmosphere of the group was trusting and friendly with many jokes. When one student tried to present a solution, the speed in the group slowed. Other members listened and encouraged his presentation with positive feedback, but one student began to read the next problem to herself. Another student refused to present a solution, not because he did not want to share with peers, but because he was extremely shy.

At the time the class merged, students reported that their groups solved the problems sufficiently. No confusion was reported. The class expected to finish soon, and I invited students to spend the rest of the time talking together about our activities. My intention was to ask the students to review their behaviors in the group work in order to change some of their behaviors if necessary. Because the students were expected to be mature enough to assess their own behaviors, I asked them to compare their behaviors themselves with the necessary behaviors that they were told about in the beginning. I expressed my wish to see more helping behaviors in the groups and asked the students if they had any difficulty when solving problems in small groups. A female student said that she thought learning together was very helpful, but the difficulty was that some students did not prepare the problems in advance. Immediately, many students supported her ideas. A male student said, "We need to prepare better before going to the group work." When I asked him if he prepared enough for the group work, another female student laughed at him and said, "Not yet!" He smiled and said, "I invested much time and effort in this subject. I studied it every week from the beginning of the semester. But

I had many things to do besides the studying." Some students confirmed that they were in the same situation.

October 19, 1998

The class met regularly with 24 students. In the previous class, I saw members of Group 1 spend a lot of time at the beginning of the tutorial working individually before discussing the problems as a group. The situation reoccurred on this day. After the individual study, a male student led the group work, starting with the problem 3-12 while students were expected to solve three problems, 3-10, 3-11, and 3-12 (see appendix A), from the easiest to the hardest respectively. He explained that members in the group did not prepare the problems 3-10 and 3-11 in advance except him. But in the lecture period on that day the instructor had just taught something related to problem 3-12, so the leader said, it was better to solve that problem first. I was very sorry to see this because our discussion from the previous week about the importance of preparation for the group work seemed to be ineffective.

The leader of the group posed subsequent questions to direct the discussion and answered several of his own questions after short pauses without any response. Other members questioned the reasons for the previous solutions. This group worked in a quiet and unenthusiastic atmosphere. I felt really frustrated when one member asked a question that required more explanation, but no one could answer. Finally, the group solved problem 3-12 with considerable help from the teacher. This group was created first, based on "friends who already studied together" as I explained before, however, due to a lack of

preparation for the group work, they appeared more isolated within their group than other students.

Most groups had many difficulties with problem 3-12. This was one of the most troublesome for the students. When the class met together at the end, the teacher explained an example problem in the lecture handout, and indicated the similarity and relationship of that problem with problem 3-12 in order to help the students solve it.

October 26, 1998

Twenty-four students were present. I was apprehensive because several members of Group 1 had not prepared for the previous tutorial. I knew the level of complexity of problems in the course increased day by day and I wondered if it reduced the students' enthusiasm for the group problem solving. I decided to observe activities of other groups again. I spent much time with Group 4 and Group 5. I felt a lot better because members in these groups worked together cooperatively, except one male member of Group 4 who worked individually because he had not prepared the problems in advance. The atmosphere in the class was energetic and relaxed. Because the room was small, sometimes when the teachers explained things for a group, their neighbors listened too. Some groups required help from neighbors. They seemed ready to share their understanding.

Group 4 got into a controversy when a member suggested a "wrong" solution. Another group member asked for the reasoning of the answer. The first student explained her answer to the satisfaction of some group members, but not all. The group could not come to a conclusion. With the more difficult problems, groups became "stuck" more

frequently and required more assistance from the teachers. Several students commented that in such situations, it was easier to understand the teachers' explanations than those of peers in the group.

When I gave the students the survey questionnaires (Appendix F) to complete, they knew the time I required them for my study had ended. I asked them what we should do in the next tutorial period. The class agreed to continue solving problems in small groups. The instructor considered that it was the wise decision. None of the students wanted to switch groups.

Data collection procedures

In order to explore the students' attitudes and beliefs about cooperative learning approaches, two major techniques, observations and interviewing, were used to collect data in this study. Observations were recorded by taking notes as well as videotaping students when they were engaging in the group learning. The students' opinions about cooperative learning were solicited through a survey questionnaire and informal interviews.

Observation

Videotape has been used widely as a tool for educational research (Fraenkel & Wallen, 1996; Woo, 1991). However the use of videotapes in this study was limited. At first, some students in the study hesitated to be videotaped although I explicated my purpose and guaranteed that the tapes would not be used for any other purpose. When we changed the tutorial schedule and began using the smaller room, the videotaping became

inconvenient. No more groups agreed to be videotaped. Therefore the videotaping was carried on for three periods with three groups only. In contrast, the students did not object to my observations. I stayed beside the groups, observed their work and took field notes. My observations and field notes could not be continuous, however, because sometimes other groups needed my help. In each tutorial period, I tried to focus at least one group. Every group was observed or videotaped at least once (Appendix G) with the hope of capturing as much as possible the "whole picture" of the students' behaviors.

Interviewing

Interviewing is an important data collection technique to find out things we cannot observe directly:

The fact of the matter is that we cannot observe everything. We cannot observe feelings, thoughts, and intentions. We cannot observe behaviors that took place at some previous point in time. We cannot observe situations that preclude the presence of an observer. (Fraenkel & Wallen, 1996, p. 447)

Informal interviews were carried on throughout the study with individuals or with groups of students. The students in this class were encouraged to see and talk with me about their concerns with this learning approach. I also interviewed informally some students after observations to get some insight into their behaviors in the group work as well as how they learned in this course, what they thought about the learning approach. Usually, these interviews were not too long. Students' responses were noted after interviewing in order to prepare the survey questionnaire.

Survey questionnaire is a type of written interview to collect opinions in a large group (Fraenkel & Wallen, 1996). Because individuals are different, I decided to survey

all the students in the study to seek a comprehensive picture of their opinions about this learning approach.

Some items for the questionnaire were based on the survey questionnaires of the studies of Towns and Grant (1997) and Wright (1996), these items were adjusted to fit the study. Others were developed by the investigator on the basis of her observations and the concerns of the students that emerged from the informal interviews. The instructor of the course was invited to read and comment on the items in order to revise them with the hope that the items would be easily understood by the respondents. Finally, the survey questionnaire with 20 closed-ended and 3 open-ended questions was sent to the students (Appendix F). The closed-ended items covered four dimensions: students' behaviors with peers (items 3, 4, 5, and 8), students' studying for the course outside class (items 1, 6, 18 and 19), students' cognitive beliefs about cooperative learning (items 9, 10, 11, 12, 13, 17 and 20), and students' attitudes toward cooperative learning (items 2, 7, 14, 15, and 16). Both positive and negative items were included in each dimension. The students had opportunities to explain their attitudes, to evaluate the format of this learning approach and to provide their suggestions for cooperative learning approaches in the open-ended items.

On October 26, I handed out questionnaires to the 24 students who were present that day. Three others were held by the class leader to be given to the absent students when they returned. Because we had no chance to pilot the questionnaire, the items were explained to the students and they were shown how to respond. The students were encouraged to give their honest answers. They completed the questionnaire at home. Twenty-four completed forms (89%) were returned to me through the class leader in the

next two tutorial periods. Most students answered all the open-ended questions indicating the students were very concerned with cooperative learning as well as their learning conditions.

Data analysis procedures

The tapes and field notes were transcribed by the investigator. The transcriptions were reviewed and rechecked in Vietnamese. They were analyzed twice by using general terms to put students' dialogues and gestures into several codes. The first time was after each tutorial class. When the study ended, I reread the transcriptions, checked the former codes and modified some terminology. The summary of these important events in my opinion was reported in the previous part of this chapter. Appropriate quotations were chosen and translated into English for this report. Data from informal interviews were analyzed in the same way.

The 24 returned questionnaires were checked. One could not be used because the respondent adjusted the questions in the questionnaire to fit her opinions. As a result, 23 returned questionnaires from 9 female and 14 male students contributed to the findings of this study.

Responses to closed items on the questionnaire were counted and reported in terms of the percentage format (Appendix H). In contrast, responses from open-ended questions were treated as other qualitative data.

Information from all data sources was compared. Syntheses of the information are presented as the findings of the study in the next chapter.

CHAPTER 4

FINDINGS

In this chapter, information obtained from the study is presented in three themes consistent with the problem of the study: (1) students' behaviors in terms of their interactions when they were studying in the cooperative learning environment; (2) students' beliefs about cooperative learning; and (3) attitudes of the students toward cooperative learning.

1. Students' behaviors when they were studying in the cooperative learning environment

The overall picture of students' behaviors when they studied within groups was described in the previous chapter. It seemed that the students acted differently each other when they were grouped to solve problems together. However, several behaviors were seen regularly in the groups during the observations, and were confirmed in the survey questionnaire. Some significant behaviors that related to students' interactions in cooperative learning environment are presented in this section.

(i) Evidence from observations of the group work revealed that, most of the time, groups worked energetically. Although leaders did not appear consistently, many questions related to the problems were posed to direct the solutions or to seek the reasoning behind the solutions. Those questions raised the energetic atmosphere in the groups. In general, female students frequently posed questions and contributed to the groups more smoothly than males.

The questionnaire data revealed that most students who spent much time at home to study and who prepared carefully for the group work were female. Actually, 67% of the female students in the class spent more than three hours a week studying this course at home, and 67% of the female students tried to solve the problems before the tutorial periods. Only 14% of the male students in the class spent more than three hours a week on this course at home, and 21% of the male students prepared for the tutorials by trying to solve the problems in advance. Maybe this is the reason why the female students seemed to be more active in the groups than the male students.

(ii) An obvious difference between the cooperative learning environment and lecture-based environment was that the students became more active in the cooperative learning environment than they had been in the lectures; 91% of them felt comfortable talking about their confusions and discussing with peers, especially when some students had "... misunderstanding in the simple problems, but I dared not ask the teachers." Communication in the tutorials was quite different from the lectures. In the lectures, the students listened to the instructor, and took notes. No one asked questions. But in the tutorials, they posed questions frequently in the groups. All the groups in the class asked their neighbors or the teachers for assistance when they could not solve the problem within the group. Some students were brave enough to discuss with the teachers or class about their understandings or confusions. Many students discussed their confusions with me individually before and after classes, something that rarely happened when I taught other tutorial classes in the past. The truth is that when Vietnamese children are growing up, they are taught polite behaviors, such as to respect teachers, to keep silent in class,

and not to interrupt teachers. These habits accompany students to undergraduate lecture classes until a change is suggested and encouraged by teachers.

(iii) Observations of student-student interactions revealed that many students expected their group members to participate voluntarily in the shared task. Now and then, when a student only looked on while his/her group-mates were interacting, group members sometimes asked if he/she was keeping up or understood the solutions. But participants were really involved in the group work only when they began to present their questions or ideas themselves. Only 43% of the students said no to the statement "I rarely asked others who did not voluntarily participate in the group work," while 48% were unsure of what they did in those situations.

Informal interviews with the students regarding this problem revealed that the main reason some students seemed passive in the groups was that they had not prepared enough for the group work. This was consistent with the fact that female students prepared more carefully and engaged more actively in the group work. Their group members suggested that the unprepared students should try to prepare better for the next tutorial. In conversation with me, one female student said:

In my group, everyone voluntarily posed questions and answers. Anyone who cannot keep up with the information must ask immediately. If one only watched others working, I would not like to accept him/her as a group member.

The students participating in this study had studied in the university for three years or more. Because individualistic learning environments have dominated our universities for a long time, students are expected to be self-discipline in their learning and to voluntarily involve themselves in learning processes. They brought those habits to

a group learning environment when interdependence among the group members was something that was not familiar to them. Data from the survey revealed, 35% of the students asked their group-mates to make sure they understood the problems when they studied together in small groups. Because the time for the group work was fairly short, they could not require group members to rephrase what other members had said.

(iv) The facts that there was little time for paraphrasing what peers had said and the students expected their group members voluntarily participate in the share task did not mean the students disregarded their peers' learning. The students appeared to interact fairly with peers; 87% of them disagreed with the statement "I did not like to hear group-mates present the answers that I already knew." When the "unprepared students" mentioned above began to require help from the group-mates, the situation became different. The group members eagerly explained again, sometimes the whole solution.

One student told me that:

My group worked so slowly because T. and Tr. (two members in the groups) rarely prepared the problems in advance. But they did ask about the problems. We (she and another member in the group) were willing to answer. But it took lots of time to explain for them, so we could not solve as many problems as other groups.

Results from the survey questionnaire indicated 91% of students in the study were willing to explain things to friends to help them become more knowledgeable. This was the predominant behavior of the students when they studied together. They were willing to share their understandings with peers no matter if they were group-mates or not, high or low ability. In this environment, 91% of the students said they felt comfortable when working within their groups.

I know some Vietnamese students to be willing to help friends outside classes by giving explanations when their friends require them. Maybe this behavior developed well when students were taught "necessary behaviors" for learning in the groups.

2. Students' beliefs about cooperative learning

Students in the study believed that to learn cooperatively was helpful. Although each student recognized the usefulness of cooperative learning in different aspects and levels, no one judged the group-work periods to be a waste of time.

(i) Observations the group learning of the students showed that in the group learning, the students posed many questions related to problems solving and supposed explanations for the solutions of the problems solving or to resolve their peers confusions. Most students in the class clearly agreed that studying in cooperative learning environment increased their understanding. One student stated:

Learning in the group helped me overcome my misunderstandings. I had opportunities to check my knowledge myself, as well as to increase my understanding and learn good problem solving strategies from peers.


In the survey questionnaire, 96% of students in the class believed that they understood the problems better after working within groups, 91% of them agreed that questions of their peers made them think about the problems more deeply, and 70% of them confirmed group-mates helped them overcome their misunderstandings. Some students believed their thinking ability was developed in cooperative learning environment. Many students clearly expressed the benefit of the cooperative learning approach with their knowledge or their thinking ability:

When we confronted a difficult problem, each member in my group might understand a part of the problem, we shared the ideas and discussed together. It made me see the problem in different ways, understand it more deeply and improve my reasoning ability.

When we tried to solve problems in the group, many questions of my friends made me think more deeply about the problems. Sometimes none of us knew the answers, but from discussions together, the answers became visible.

Discussion with friends helped me acquire the solutions faster and more clearly than I do myself. It also made me recognize the connections among problems. It stimulated me to think more abstractly.

(ii) When observing students' learning in the tutorials, I recognized some students were not stimulated to learning. In the survey questionnaire, 70% of the students reported that the group work encouraged them to study every week, 78% of participating students said they usually prepared the problems before the tutorial periods, and 61% confirmed they continued to study the problems themselves after the group work to insure their understanding. Indeed, 70% of the students reported that they prepared fairly well for the group works by solving the problems or sketching the answers in advance. These survey results were consistent with my observations. I noticed that the students tried hard to do well with this new learning approach. Students in the class attended 30 academic hours or more each week, and many of them carried a part-time job to support their study, or took extra courses in foreign languages or computers to prepare for their jobs after graduating. But most of them appeared to study hard in this course.



Many students reported that the group work forced their studying. One student expressed:

I usually study only when the final exams are coming. In the beginning of this course, I studied frequently because of the requirement of the group work. But when my misunderstandings were solved in the problem solving periods, I could

adjust my understanding in time for the next lessons. I felt excited and I strived more to solve problems every week.

Some students said that they felt more responsibility for learning:

I felt that such studying was fun and comfortable. We are in an environment in which self-study is the norm. Everyone has to try for his or her own learning. I feel more responsible for my learning.

Another student reported that, "I knew the results of my studying depended mainly upon my effort to learn. But the enthusiasm of the teachers really encouraged me to study hard in this course."

(iii) Although the communication aspect of cooperative learning was not discussed in the informal interviews with students or in the close-ended questions in the survey questionnaire, some students said learning in the cooperative learning environment helped them have better relationship with classmates. They said, "...learning together created a harmonious relationship with friends. It helped me understand my friends better," or "the group learning created an opportunity for the friendships in our class to increase very much." Generally, the environment of the class was relaxed and full of mutual help.

In the cooperative learning environment, the students had many opportunities to present their ideas to peers. One student also reported that, "... through the group discussion, I learned the ways to express a problem to others clearly and understandably."

(iv) As mentioned in the previous chapter, most of students in this class had an opportunity to study cooperatively before, so that in the beginning, they suggested creating larger groups with six or seven members, and dividing tasks. But after the six-

week experience with the format of small groups and non-divided tasks, these aspects were judged favorably with 87% of the students agreeing that group size was suitable with three to five members. They said that:

The groups with four students were easier to learn. In the groups with many members, it was difficult to become coherent, and we used to spend time talking more than studying.

Because the number of members in a group was less, I felt that it was easier to share ideas and discuss together. Non-divided tasks made me have to solve all the problems, and I really understand all the problems more clearly.

Every member in the group is responsible for preparing for all problems, so everyone could understand the problems more easily and completely.

I think the small groups with four or five members are very comfortable. It made everyone feel more responsible. The opportunity to take turns to present a problem increased too.

Non-divided tasks made everyone prepare all the problems. So we had many ideas to share and discuss with the group-mates.

With the strong belief that cooperative learning was helpful for their learning as indicated in the findings above, none of the students believed study in heterogeneous groups was ineffective and 52% of the students disagreed with that opinion on the questionnaire.

Some students also believed that learning together in the class was better because:

The teachers presented in the class when we discussed the problems, we could ask the teachers to solve our difficulties in time in order to continue to solve other problems. That made us pay more attention to the task, we did not waste the time talking.

(v) The students in the study not only believed cooperative learning had positive effects on their learning, but they also knew that their group work was not ideal and

suggested ways to improve it. The predominant concern of the students was the need to prepare the problems before the tutorials. Results from the survey questionnaire revealed that 70% of students in the class suggested everyone needed to prepare carefully for the group work. Not only did the students who had already prepared for the group work suggest this, but also the students who only "glanced over the content of the problems" before the tutorials knew that "I have to try more myself to prepare for the group work."

A student emphasized that, "solving problems in groups was most effective when we prepared the problems in advance." One student established, "when I did not prepare a problem before, I watched my friends solve it but felt left out." Others said that:

If all of us are ready for the group work by reviewing the problems oneself to know what makes us confused, what we can do or cannot, our learning in the groups will be more fast and effective.

All of us have to prepare the problems in advance. I think we only discuss the problems that are confusing in the group work. If some student began to read materials in the group work, others would feel bored because they spent too much time to orient the unprepared persons without learning anything.

Students also recognized that they needed to be involve more boldly in the group discussion: "All of us need to present the right solution in one's opinion," or "everyone had to ask immediately when confusing the explanations of friends." These concerns are consistent with the fact that many students wanted their peers to involve themselves voluntarily in their learning. In addition, if a misunderstanding in a problem is not resolved in time, students may be more confused by further explanations.

(vi) Besides making suggestions for themselves, some students suggested ways for the teachers to better facilitate their learning. They said, "we need more time for group work because the problems solving became more and more difficult," and

“teachers should have given the best solution of problems after the group work.” Other students suggested, “we should have evaluated the group work in order to know if the groups worked effectively,” or “we would have had exams to stimulate our learning.”

Although these suggestions arose from a minority of students in the study, it showed that the students were sensitive to their learning conditions. All the suggestions above were from the students who liked cooperative learning, indicating that they judged the cooperative learning method fairly and their opinions were trustworthy.

3. Students' attitudes toward cooperative learning

Based on students' behaviors with friends and their comments about cooperative learning, their attitudes were not too varied. In fact, 91% of the students felt comfortable when working within groups, 83% students liked the learning approach in the study, only 9% students stated they did not like learning cooperatively. Irrespective of their attitudes toward this learning approach, 87% of the students submitted the reasons for the views they reported.

Statements of the students indicated that their positive attitudes were strongly influenced by their understandings of the value of this learning approach rather than their feelings. The perceived value of cooperative learning of the students could be classified into three categories: (1) students' understanding of chemistry increased and their reasoning ability was developed when they learned cooperatively within groups; (2) cooperative learning stimulated efforts of students to learn; and (3) they gained benefits in intercommunication through cooperative learning. The superlative reason why the students like cooperative learning is the first category. The details of the reasons for

students' positive attitudes toward cooperative learning were considered earlier in this chapter, in the findings of students' beliefs about cooperative learning. A minority of students liked cooperative learning because they felt interested when solving problems in groups, or they felt more responsible for their learning.

Students who did not like learning within their group had different reasons.

Although the negative attitude toward this learning approach was not common for most of the students in this study, we should achieve a better understanding about students' attitudes when examining their reasoning. One student believed that learning in heterogeneous groups was helpful only for average students:

I did not like cooperative learning because I could not choose the group-mates to fit my view. The teacher required us to choose heterogeneous groups in terms of academic ability. In this condition, only students with lower ability can improve their performances. In my opinions, in order to improve academic performance by learning together, we have to learn in homogeneous group. If members in the group differ from each other in academic ability, the higher ability students will only lose time.

Disregarding homogeneous or heterogeneous groups, this student affirmed that her understanding the chemical problems was enriched due to solving problems together, and the group work stimulate her to study every week. Maybe with this student, academic performance was an important goal in learning. She thought she could get the same understanding when she learned alone or she could learn more if working with higher abilities students. In other ways, maybe some group-mates of this student usually did not prepare for the shared task. She had to spend much time to teach them, so she felt she "lost time." This reasoning is consistent with the explanation of another student when she suggested ways to improve group work in the cooperative learning environment.

Another student thought cooperative learning develops a tendency to depend on friends:

- I did not like this learning approach because it made me think that if someone did nothing, others would do it and would show the ways to do. It did not make me try to do it myself.

A possible reason for this student's complaint is that his learning operates on the principle of minimum effort (Herron, 1996):

Because energy is limited and learning is directed toward survival, we seek to learn with the least cognitive effort. When confronted with alternatives, each of which appears to have the same survival value, we select the alternative that requires the least effort. (p. 18)

Because our students were more familiar with the lecture method, they were used to receiving explanations from teachers, so their learning relied on teachers more than on themselves (Tertiary education system lacks quality, 1998). I considered that this student had shifted from a state of "reliance on teachers" to another state of "reliance on friends" because this required less energy of him in the cooperative learning environment if friends were willing to help him and an evaluation was not administered.

Although the students' opinions about this learning approach were mixed, none of them refused to learn together in future. In the questionnaire, 74% of the students assured that they wanted to continue to study cooperatively in the rest of the course, 65% of them said they would like more opportunities to learn with friends in other courses. The fact that these percentages are somewhat lower than of the students who liked cooperative learning (83%) can be clarified by the students' familiarity with the lecture method of their teachers. Vietnamese students are used to a more traditional teaching-learning environment. Of course, the explanations of teachers are usually clearer than those of

friends, especially with complex problems. Evidence from the observations revealed that the students regularly required help from teachers when confronted with controversies in chemical knowledge. In some cases, the students seemed weak in knowledge or the tasks were really difficult. They did not find sufficient explanations to persuade or reject an answer, likely because they had not asked the right questions and reasoning about the solutions in problems involving controversial situations. So in the survey questionnaire, 56% of the students could not decide what they preferred, the solutions of their teachers, or the answers they found out themselves with peers.

A week after the students responded to the survey questionnaire, I saw some students discussing a plan of learning together for another course. They told me that "After half a semester of solving problems together, we feel confident in this course because we can keep up with the lecture. The teacher of the course 'Radiochemistry' just gave problems for the course, we think it is better to begin to study now." They confirmed that the plan to solve problems cooperatively for the course "Radiochemistry" was their own plan. Anyone who wanted to participate would be welcome. I was very please because these students really thought learning together helped them and they liked it.

CHAPTER 5

DISCUSSION AND RECOMMENDATION

This chapter begins with discussions of the findings presented in the previous chapter. Following that, limitations of the study are noted, together with suggestions for further research. At the end, this chapter addresses recommendations for higher education in Vietnam.

Discussion

Generally, the findings of the study showed that the students in this study recognized the value of the cooperative learning approach for their learning. They liked cooperative learning and exhibited positive behaviors when studying in a cooperative learning environment. These findings were consistent with the comments of Tribe (1994) about cooperative learning in higher education: "... most students are quick to see the advantages of group learning methods and will adapt relatively rapidly to a change of approach" (p. 29). I notice that, although the learning context of Vietnamese students is somewhat different from that of students in Western countries, characteristics of students in terms of human learning are not too different, criteria for assessment of knowledge are similar for the two contexts. That may be the main reason why our students have the same opinions and responses to the cooperative learning approach as of students in other studies.

Based on that explanation, it is reasonable to expect that the effectiveness of this cooperative learning approach on our students' learning is similar to the results of

previous research in cooperative learning. In fact, this study did not directly evaluate the effects of cooperative learning on students' learning, but data from observations and reports of the students suggested the main effectiveness of cooperative learning on students' learning in our context. Findings of this study indicated that students became more active and they tried to study hard in a cooperative learning environment. The majority of students believed that their understandings were enriched and their reasoning abilities were developed in this learning environment, and learning together enhanced their interpersonal relationships.

The findings of this study indicated that the students interacted together fairly well in a cooperative learning environment with their predominant behavior being "willing to help friends" even though there were no "bonus points" for this. This result is consistent with the findings of Slavin (1995), who found that students could be taught communication skills and work well within groups without the need of rewards beyond that of attaining higher performance.

The willingness to help friends is a strength of Vietnamese students when they learn together. However, in a cooperative learning environment without evaluation as in this study, this strength sometimes enables some students to develop an undesired tendency, "reliance on friends." I noticed that this problem has not been reported before, and differs from the "hitch-hiker" or "social floating" problems (see Cooper, 1995; Johnson & Johnson, 1994; Ormrod, 1999) in other studies in which some kinds of evaluation of the group work have been carried out. The "hitch-hiker" exists when groups are scored based on a single report, some students do most of the task while others get a free ride. The "social floating" happens when groups are scored by summing the scores.

of group members, and many members tend to reduce efforts without other members realizing that they are doing so.

In this study, the tendency to rely on friends appeared with some students who did not prepare well for the group work. Behaviors of these students may have had a negative effect on the learning of others in a cooperative learning environment. In conversation, one student said:

Some students did not prepare for the group work, even by reviewing the theory. They asked something that they should not have asked. We were willing to help. But it reoccurred many times, and it made some of us feel bored.

The question of how to develop the strength of our students, as well as how to limit the problem of “reliance on friends” has to be considered carefully in future uses of cooperative learning in the Vietnamese context.

As mentioned in the literature review, homogeneous or heterogeneous grouping of students is a big concern of teachers and researchers using cooperative learning strategies. In this study, although none of students affirmed “studying in heterogeneous groups is ineffective,” 48% of the students could not be sure if studying in heterogeneous groups was effective. Especially, one student did not like cooperative learning because she thought the higher ability students could not improve academic performance and “only lost time” in heterogeneous groups. Her complaint is somewhat similar to the concern of Robinson (1990) noted in the literature review. In the previous chapter, some reasons were suggested to explain student’s complaints about heterogeneous groups. First, the problem of “improving academic performance” is always a concern in cooperative learning. The question that which students gain most in terms of academic

performance in cooperative learning has had different answers. In some studies, the answer was the high-ability students; in other studies the answer was the low-ability students (see Slavin, 1995). But high-ability students occasionally lose ground (Ormrod, 1999). Sometimes, a "ceiling effect" can be explained for the lack of improving academic performance of high-ability students. So increasing knowledge and reasoning ability is more important than improving academic performance. The emphasis on the affective domain in learning is also necessary with students in a cooperative learning environment.

Second, the problem of "lost time" may relate to the "unprepared students." As stated earlier, some students were not interested or stimulated in the project, that may be a reason for "unprepared" problem. Otherwise, in conversations with students, I knew at least three students that usually did not prepare for the group work. All of them were low-ability students. So, in our context, a problem that may occur in heterogeneous groups is some low-ability students may not prepare for the group work, high-ability students may feel bored because they "lose" time orienting the unprepared students.

As noted above, the problems of "unprepared students" and "reliance on friends" may be related. These problems may have a negative effect on learning of other students in heterogeneous groups. However, as mentioned in the literature review, cooperative learning with homogeneous group seems less beneficial than with heterogeneous group. So, how to stimulate the maximum number of students to prepare carefully for the group work is still a question for teachers who want cooperative learning in heterogeneous groups to be more exciting and beneficial for many students.

Limitations of the study and suggestions for further research

Data in this study were collected and analyzed by the investigator, mainly in the qualitative style. Although I tried to collect data as objectively and much as possible, to treat both positive and negative information fairly, and used information revealed from the students to interpret the results, the biases of the investigator cannot be avoided absolutely and may have influenced the findings. The study was conducted in a short time. It was impossible to repeat observations in every group. So the reliability of the data from observations was limited.

The findings related to students' knowledge (such as, students' knowledge increased in cooperative learning) were based on self-reports of students and on the observations of the investigator. Knowledge of students on the course content was not directly assessed so the accuracy of these reports is open to question. Further research should investigate changes and differences in students' understanding by comparing students in cooperative learning to students in the lecture format. The details of the ways student interactions in the groups increased their understanding will need to be investigated, too.

The effects of cooperative learning on students psychological adjustment were not considered in the study. However, when the course ended, some students told me that they felt more confident in learning. A male student, who scored "below average" in the course Phase diagrams in the previous semester, said, "Previously, I was very scared with the course Phase diagrams. But now I am not afraid of phase diagrams at all. I am sure I will get high scores this time." As a teacher, I am really happy to hear such thing from the

students. I think this is an interesting topic for research in cooperative learning in the future.

The students in this study had more than three years experience with learning conditions in the university. This experience was based on independent studying. Teachers rarely paid attention to students' learning. We cannot generalize the findings of this study to other students, especially freshmen students who may not have the same attitude, beliefs or behaviors with cooperative learning approaches as the students in this study. Further studies in cooperative learning need to consider freshmen students.

From the study, a question emerged, what kinds of problems appeared when our students were working together in heterogeneous groups. Some ideas related to this question were discussed in this study (eg., lack of preparation), but there have not been complete answers to this question. Further research in cooperative learning in Vietnam needs to pay more attention to potential problems of heterogeneous groups and to seek ways to improve the learning of all students.

Recommendation for higher education in Vietnam

Throughout the study, I noticed that most of the students became active in the cooperative learning environment. Students appeared very keen to be aware of the reasoning of other students and to increase in their own knowledge. There are many teaching methods that can increase students' knowledge in the subject matter. With the cooperative learning method, maybe students not only increase their understanding in the subject matter but also increase their responsibility for their own learning as well as their interest in learning. About 70% of students in this study adopted these benefits fairly

well. In my opinion, cooperative learning approaches can be helpful and suitable to Vietnamese students. Vietnamese teachers in higher education can use cooperative learning as a tool to help our students learn more effectively.

Because students are different, some students in this study did not prepare for the shared task or developed a tendency of "reliance on friends." The lack of preparation for the group work not only prevented the "unprepared members" from engaging well in their groups but also influenced the learning of other students. Teachers must encourage students to prepare for the group work if using cooperative learning. Otherwise, I think a kind of evaluation, such as "peer evaluation" in preparation for problem solving may reduce the non-preparation problem. As some previous studies (e.g., Dinan & Frydrychowski, 1995; Wright, 1996), teachers can discuss with students to decide if a peer evaluation process in preparation for problem solving is necessary, and a reasonable proportion of grades for peer evaluation.

The time for this study was short (in six weeks, an hour a week) and the content of the course for senior students was very heavy. We, both the teachers and the students, were very busy with the course material, especially the students. They studied very hard in the tutorial periods. We had no time to learn and practice many useful behaviors in cooperative learning, such as leader role or solving controversy. I think we should try cooperative learning with many courses from the first year of the undergraduate program. If we can do so, students not only will become more responsible for their learning, but also have a longer time in the school to develop behaviors needed for future lives.

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APPENDIX A

QUESTIONS AND PROBLEMS FOR TUTORIALS OF THE STUDY

UNIT 1: Basic terms and concepts

- 1-1. a. A pure copper bar is heated continuously at one end. How many phases does it have?
- b. Suppose that a system includes 10g of water and 10g of LiCl. How many phases does it have in equilibrium state at 0°C, 20°C, 60°C, 96°C and 100°C? The solubility of LiCl in aqueous solutions (S) and the coexisted solid phase in equilibrium state at different temperature is given in table 1-1.

Table 1-1: The solubility of LiCl in aqueous solutions.

T (°C)	S (g LiCl per 100g H ₂ O)	Solid phase in equilibrium
0	68.3	LiCl·2H ₂ O
20	83.2	LiCl·2H ₂ O + LiCl·H ₂ O
60	98.8	LiCl·H ₂ O
96	127.3	LiCl·H ₂ O + LiCl
100	128.8	LiCl

- 1-2. Evaluate the number of components in each of the following systems at equilibrium:
- a. System of CO₂, CaO, and CaCO₃.
 - b. System of Na₂CO₃, KCl, and H₂O.
 - c. System of H₂, I₂, HI in the vapor phase, starting with only HI.
- 1-3. Evaluate the total number of constituents, the number of distinct chemical reactions can take place in the system, and the number of constituents in the systems of H₂O – H₂SO₄ and H₂O – FeCl₃ in the figure 1-1 and 1-2.

Figure 1-1: Phase diagram for system $\text{H}_2\text{O} - \text{H}_2\text{SO}_4$

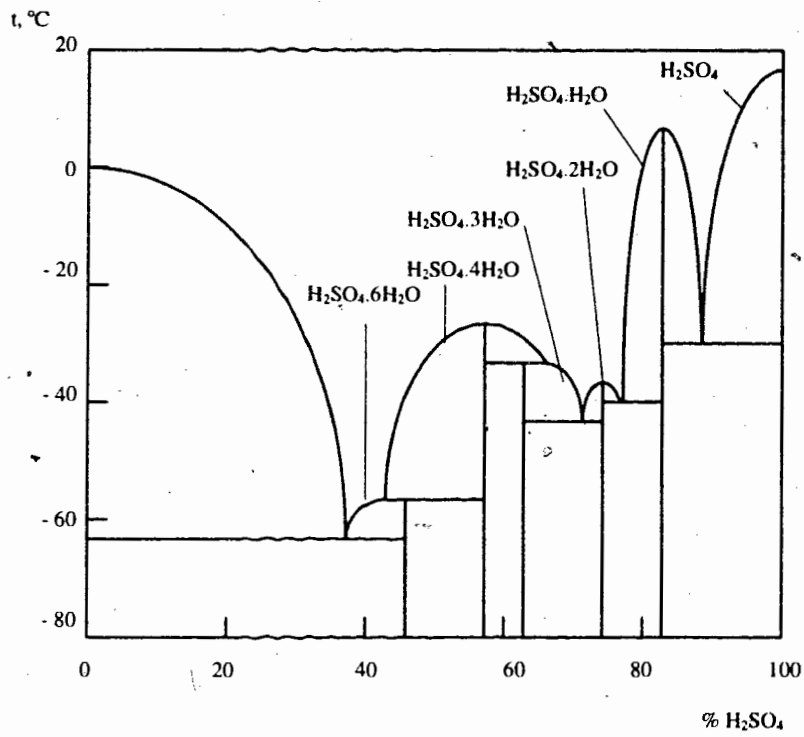
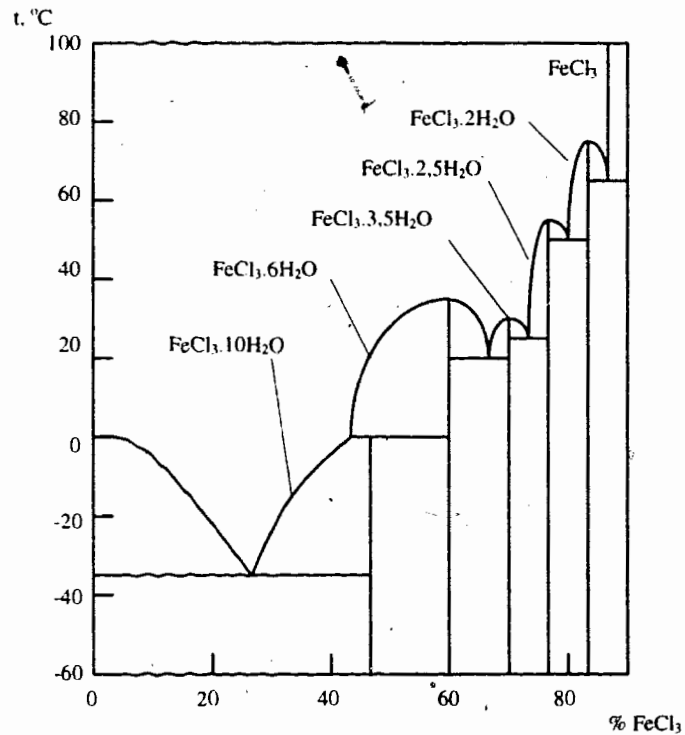


Figure 1-2: Phase diagram for system $\text{H}_2\text{O} - \text{FeCl}_3$



UNIT 2: Two-component systems: water and a salt.

2-1. Draw the solubility curve for system $\text{Na}_2\text{CrO}_4 - \text{H}_2\text{O}$ in which the concentration of components is presented on percentage of weight. The solubility of Na_2CrO_4 in aqueous solutions (S) is given in table 2-1 in terms of g Na_2CrO_4 per 100g H_2O ; n was the number of molecular of water coexisted with one molecular of Na_2CrO_4 in solid phase at equilibrium state.

Table 2-1: Solubility of Na_2CrO_4

T ($^{\circ}\text{C}$)	0	19.4	25.9	40.0	64.0	80.0	100.0
S	31.8	78.9	85.2	95.3	122.7	124.7	126.7
n	10	10 + 6	6 + 4	4	4 + 0	0	0

Draw the branched curves of saturated solutions in two ways mentioned in the lecture and estimate the error of the two methods.

2-2. 1000kg of an aqueous solution containing 55.0% Na_2CrO_4 at 100°C is cooled to 40°C . Indicate the solid phase separated. Calculate the weight of the solid phase in two methods:

- Using the level rule.
- Using the principle of the conversation of mass.

UNIT 3: Three-component systems: water and two salts with a common ion.

3-1. Draw the isotherm diagram for solid-liquid equilibrium of aqueous solutions of two salts NaCl and KCl at 100°C . Table 3-1 gives analysis of saturated solutions and indicates the solid phase in equilibrium for the system $\text{NaCl} - \text{KCl} - \text{H}_2\text{O}$ at 100°C .

Table 3-1: Solubility of NaCl and KCl in aqueous solutions at 100°C

Points	Composition of solutions (% wt.)		Solid phase
	NaCl	KCl	
A	28.3	0	NaCl
B	16.9	21.7	NaCl + KCl
C	13.4	24.4	KCl
D	0	36.0	KCl

3-2. Draw the isotherm diagrams for solid-liquid equilibrium of system NaCl – Na₂CO₃ – H₂O at 25°C in which compositions are presented in an isosceles right triangle and in a rectangular coordinate. Discuss the strength and the weakness of each method. Solubility of system is given in table 3-2.

Table 3-2: Solubility of NaCl and Na₂CO₃ in aqueous solutions at 25°C

Points	Composition of solutions (% wt.)		Solid phase
	NaCl	Na ₂ CO ₃	
A	21.3	0	NaCl
B	15.5	17.3	NaCl + Na ₂ CO ₃ .7H ₂ O
C	13.0	18.4	Na ₂ CO ₃ .7H ₂ O
D	11.8	19	Na ₂ CO ₃ .7H ₂ O + Na ₂ CO ₃ .10H ₂ O
E	10.8	18.8	Na ₂ CO ₃ .10H ₂ O
F	5.6	19.6	Na ₂ CO ₃ .10H ₂ O
G	0	22.7	Na ₂ CO ₃ .10H ₂ O

3-3. Draw the isotherm diagram for solid-liquid equilibrium of system K₂SO₄ – MgSO₄ – H₂O at 25°C in an isosceles right triangle and in a rectangular coordinate.

Solubility of the system is given in table 3-3.

Table 3-3: Solubility of system $K_2SO_4 - MgSO_4 - H_2O$ at $25^\circ C$

Points	Composition of solutions (% wt.)		Solid phase
	K_2SO_4	$MgSO_4$	
A	10.8	0	K_2SO_4
B	10.9	5.1	K_2SO_4
C	11.0	12.6	$K_2SO_4 + K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$
D	9.9	14.3	$K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$
E	7.3	20.3	$K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$
F	4.9	26.0	$K_2SO_4 \cdot MgSO_4 \cdot 6H_2O + MgSO_4 \cdot 7H_2O$
G	4.8	26.3	$MgSO_4 \cdot 7H_2O$
H	3.4	26.6	$MgSO_4 \cdot 7H_2O$
I	0	26.7	$MgSO_4 \cdot 7H_2O$

3-4. Analyze phase diagrams in figure 3-1 and label all areas.

3-5. Analyze phase diagrams in figure 3-2 and label all areas.

3-6. Analyze phase diagrams in figure 3-3 and label all areas.

3-7. Analyze phase diagrams in figure 3-4 and label all areas

3-8. Suppose a system consists of 20% A, 60% B and 20% H_2O in terms of weight. Using the phase diagrams in figures 3-3 (a) and 3-4 (a), indicate the points representing the total composition of the system and each phase in equilibrium. Use the level rule to calculate the relative amounts of each phase associated with a given mass (m) of the initial system.

Figure 3-1: Phase diagrams for ternary systems in which salt B is separated only in hydrate compound form

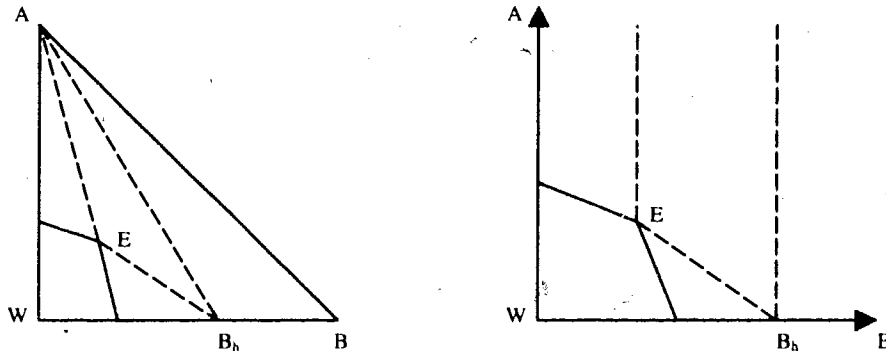


Figure 3-2: Phase diagrams for ternary systems in which salt B is separated in two forms, the anhydrate B and the hydrate B_h

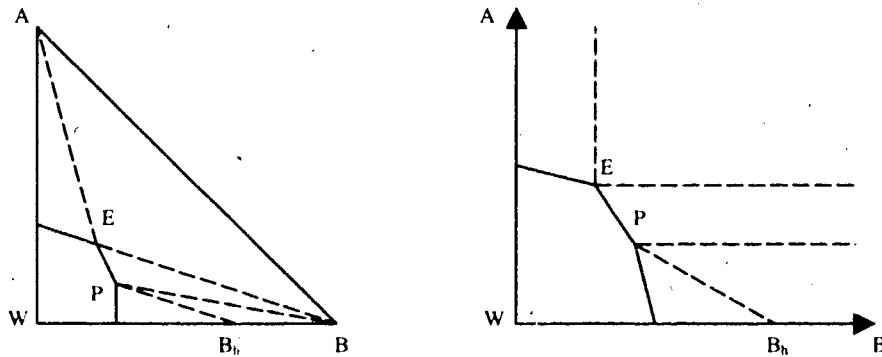
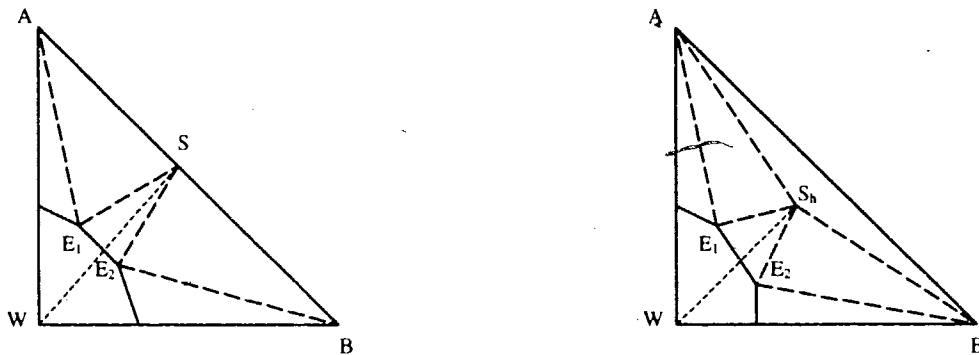


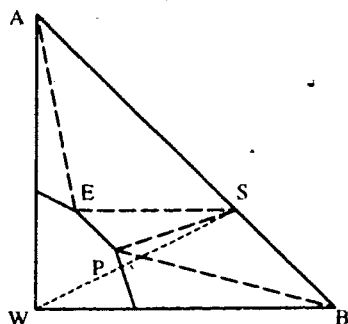
Figure 3-3: Phase diagrams of ternary systems formed a double salt congruently soluble



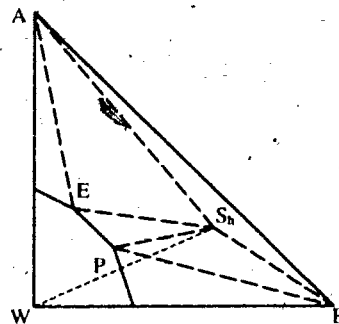
(a) anhydrate double salt

(b) hydrate double salt

Figure 3-4: Phase diagrams of ternary systems formed a double salt incongruently soluble



(a) anhydrate double salt



(b) hydrate double salt

3-9. Figure 3-4 (a) shows S is a double salt incongruently soluble. Suppose an initial dilute solution with proportion of A/B is the same with A/B of the double salt S. Estimate the processes of evaporation of water of the dilute solution.

3-10. Draw the isotherm diagram for solid-liquid equilibrium of system $K_2SO_4 - MgSO_4 - H_2O$ at $50^\circ C$. Solubility of the system is given in table 3-4.

Table 3-4: Solubility of K_2SO_4 and $MgSO_4$ in aqueous solutions at $50^\circ C$

Points	Composition of solutions (% wt.)		Solid phase
	K_2SO_4	$MgSO_4$	
A	14.1	0	K_2SO_4
B	14.4	6.0	K_2SO_4
C	13.5	13.9	K_2SO_4
D	13.0	17.0	$K_2SO_4 + K_2SO_4 \cdot MgSO_4 \cdot 4H_2O$
E	5.6	29.3	$K_2SO_4 \cdot MgSO_4 \cdot 4H_2O$
F	4.4	32.4	$K_2SO_4 \cdot MgSO_4 \cdot 4H_2O + MgSO_4 \cdot 6H_2O$
G	2.6	32.8	$MgSO_4 \cdot 6H_2O$
H	0	33.5	$MgSO_4 \cdot 6H_2O$

Estimate the isothermal evaporation processes of water for the following systems:

- 10% K_2SO_4 , 5% $MgSO_4$, 85% H_2O .
- 10% K_2SO_4 , 10% $MgSO_4$, 80% H_2O .
- 5% K_2SO_4 , 15% $MgSO_4$, 80% H_2O .

3.11. Draw the isotherm phase diagram of solid-liquid equilibrium for system $NaCl - Na_2SO_4 - H_2O$ at $25^\circ C$. The solubility of aqueous solutions of $NaCl$ and Na_2SO_4 is given in table 3-5. In each following system, estimate the number of phases existing at equilibrium. Using the tie-line, indicate the points representing each phase on the diagram.

- 20kg $NaCl$, 10kg Na_2SO_4 and 10kg H_2O .
- 5mole $NaCl$, 3mole Na_2SO_4 and 6mole H_2O .
- 20kg $NaCl$, 20kg Na_2SO_4 and 2kg H_2O .

Table 3-5: Solubility of $NaCl - Na_2SO_4 - H_2O$ at $25^\circ C$.

Points	Composition of solutions (% wt.)		Solid phase
	$NaCl$	Na_2SO_4	
A	26.6	0	$NaCl$
B	24.6	3.4	$NaCl$
C	22.7	7.1	$NaCl + Na_2SO_4$
D	18.4	10.4	Na_2SO_4
E	14.5	14.5	$Na_2SO_4 + Na_2SO_4 \cdot 10H_2O$
F	7.7	16.0	$Na_2SO_4 \cdot 10H_2O$
G	0	21.7	$Na_2SO_4 \cdot 10H_2O$

3-12. Draw the isotherm curves of solubility for system NaCl – KCl – H₂O at 25°C and 100°C. The solubility of NaCl and KCl in aqueous solutions is given in table 3-6. Suppose an aqueous solution containing 16,9% NaCl and 21,7% KCl (in weight) at 100°C is cooled to 25°C without evaporating of water. Determine the deposited solid and the solution formed in this condition. In a similar process, water is evaporated when the initial solution is cooled, indicate composition of the solution formed at the end of the process in order to obtain the greatest amount of a pure salt.

Table 3-6: Solubility of system NaCl – KCl – H₂O

T	Points	Composition of solutions (g NaCl or g KCl per 1000g H ₂ O)		Solid phase
		NaCl	Na ₂ SO ₄	
25°C	A	361	0	NaCl
	B	317	118	NaCl
	E	298	162	NaCl + KCl
	C	189	213	KCl
	D	0	361	KCl
100°C	A'	395	0	NaCl
	E'	275	353	NaCl + KCl
	B'	215	392	KCl
	C'	0	563	KCl

3-13. Draw the isotherm diagram of liquid-solid equilibrium for system MgSO₄ – K₂SO₄ – H₂O at 45°C. The solubility of the system is showed in table 3-7. Suppose that water in an aqueous solution including 8% MgSO₄, 12% K₂SO₄, 80% H₂O in weight is evaporated at 45°C. Calculate the amount of water that will have to be

evaporated off in two cases: (1) until the solution begins to be saturated with respect to K_2SO_4 , and (2) until the greatest amount of pure K_2SO_4 is deposited.

Table 3-7: Solubility of system $MgSO_4 - K_2SO_4 - H_2O$ at $45^\circ C$

Points	Composition of solutions (% wt.)		Solid phase
	K_2SO_4	$MgSO_4$	
1	13.6	0	K_2SO_4
P	12.6	16.0	$K_2SO_4 + K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$
2	10.2	20.0	$K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$
3	8.0	25.0	$K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$
4	5.0	30.4	$K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$
E	4.4	31.4	$K_2SO_4 \cdot MgSO_4 \cdot 6H_2O + MgSO_4 \cdot 6H_2O$
Q	1.8	31.6	$MgSO_4 \cdot 6H_2O + MgSO_4 \cdot 7H_2O$
5	0	32.1	$MgSO_4 \cdot 7H_2O$

- 3-14. Suppose that a dilute aqueous solution contains 2kg K_2SO_4 , 70kg $MgSO_4$ and 300kg H_2O . Estimate the processes of evaporation of water at $45^\circ C$ until the solution begins to be saturated with respect to both $MgSO_4 \cdot 6H_2O$ and $K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$.
- 3-15. Using the phase diagrams in the problem 3-12, examine what solutions that have initial component on the curve A'E' at $100^\circ C$ will be separated with respect to both KCl and NaCl when they are cooled to equilibrium at $25^\circ C$.
- 3-16. Suggest a cyclic process of separating KCl and NaCl from solutions containing 75kg NaCl and 150kg KCl in 1000kg H_2O in order to obtain the greatest amount of KCl and NaCl in each cycle.

APPENDIX B
TEACHING SCHEDULE

Week	Part 1 (6:45 – 8:00)	Part 2 (8:10 – 9:10)
1	Lecture for unit 1	Preparation for the study
2	Lecture for unit 2	Tutorial for unit 1 *
3	Lecture for unit 3	Tutorial for unit 2 *
4	Lecture for unit 3 (cont.)	Tutorial for unit 3 *
5	Lecture for unit 3 (cont.)	Tutorial for unit 3 (cont.) *
6	Lecture for unit 3 (cont.)	Tutorial for unit 3 (cont.) *
7	Lecture for unit 4	Tutorial for unit 3 (cont.) *
8	Lecture for unit 5	Tutorial for unit 4
9	Lecture for unit 5 (cont.)	Tutorial for unit 5
10	Tutorial for unit 5 (cont.)	

* : The study was conducted in these classes.

APPENDIX C
LETTER TO STUDENTS

Dear students,

You will be taking the course "Phase diagrams of solid-liquid equilibrium for aqueous solutions and inorganic salts" as a selective course in this semester. In the tutorials of the course, I will offer you opportunities to discuss in small group and help each other to solve the problems with the hope that your learning will be more effective. I also hope these activities will help you have experience to work together, and increase your self-confidence in learning.

I am doing a study in teaching and learning methods. The activities described above are parts of my study. I am inviting you to participate in the study. The study will be conducted in six weeks. I would like to observe (or videotape) your working, to get your opinions of this learning approach.

Your participation in this study is voluntary and you may withdraw from the study at any time. I will guarantee your anonymity by using a pseudonym to identify your activities and dialogue in the study.

If you have any concerns about the study, you may contact Dr. Robin Barron (604) 291-3395. If you would like a copy of research report, you may contact Dr. Allan Mackinnon (604) 291-3432.

Thank you very much for your contributions.

Sincerely,

Le Thi So Nhu

APPENDIX D

SOME NECESSARY BEHAVIORS FOR LEARNING IN THE GROUPS

- Do not leave the group when the group is working.
- All students in the group need to take turns participating in the group learning.
Everyone needs to participate in the group discussions by asking others what they are thinking.
- All students in the group need to share ideas and materials. Members in the group need to ask questions, listen carefully to what others say, discuss and correct each other's thinking.
- All students may ask group-mates for help and assistance when seeking information.
When some group members do not understand, others should offer explanations.
- Group members should rephrase what other members have said in order to make certain that a message is understood or clarified.
- When members in the group have different opinions, the group should explore various points of view and seek the reasons for each direction before reaching conclusions. All group members need criticize ideas in a respectful manner.

APPENDIX E

THE DISTRIBUTION OF THE STUDENTS IN SIX GROUPS

Group	First day					Added *	Total
1	A male	B female	B female	C male	D male		5
2	A male	B female	C female	D male			4
3	A female	B female	C male	D male		A male	5
4	A female	B male	D female	D male			4
5	A female	B male	C male	C female		C male	5
6	A male	B female	C male	D male			4

Overall total: 27

* : Added after the first day

APPENDIX F

SURVEY QUESTIONNAIRE

COURSE: PHASE DIAGRAMS OF SOLID-LIQUID EQUILIBRIUM FOR AQUEOUS SOLUTIONS
AND INORGANIC SALTS.

LEARNING ACTIVITIES: COOPERATIVE LEARNING IN TUTORIALS

RESPONDENT: - FEMALE - MALE

PART A: Please circle the appropriate number on the right which corresponds to your feeling about the statement on the left.

1. Agree 2. Disagree 3. Undecided, or not sure

- | | | | |
|--|---|---|---|
| 1. I usually tried to prepare the answers of the problems before the group work periods. | 1 | 2 | 3 |
| 2. I felt comfortable when telling my confusion and discussing with group-mates. | 1 | 2 | 3 |
| 3. I was willing to explain things to help my friends be aware of the problems. | 1 | 2 | 3 |
| 4. I rarely asked group-mates to know if they really understood the problems. | 1 | 2 | 3 |
| 5. I rarely asked others who did not participate in the group work himself/herself. | 1 | 2 | 3 |

- | | | | |
|--|---|---|---|
| 6. I solved myself again the problems after the group work periods to insure my understanding. | 1 | 2 | 3 |
| 7. I felt isolated in my group. | 1 | 2 | 3 |
| 8. I disliked to hear group-mates present the answers that I already knew. | 1 | 2 | 3 |
| 9. Group work encouraged me to study every week. | 1 | 2 | 3 |
| 10. Questions of my friends made me think the problems more deeply. | 1 | 2 | 3 |
| 11. Working in the group helped me understand the problems better. | 1 | 2 | 3 |
| 12. Discussion with friends helped me overcome my confusions. | 1 | 2 | 3 |
| 13. Group work periods were waste of time. | 1 | 2 | 3 |
| 14. I prefer the answers of the teachers to discussion with group-mates to find out the answers. | 1 | 2 | 3 |
| 15. I like to continue to solve the problems in small group in the rest of the course. | 1 | 2 | 3 |
| 16. I like more opportunity to work in small groups in other courses. | 1 | 2 | 3 |
| 17. Studying in heterogeneous groups is ineffective. | 1 | 2 | 3 |

PART B: Please mark appropriate answers for you:

18. In order to prepare for group work periods, I usually:

- try to solve the problems myself.
- sketch the answers of problems.
- glance over the content of the questions.
- do nothing.
- others: _____

19. I studied - under 1 hour a week for this course at home:

- 1 to 3 hours
- more than three hours

20. I felt my group worked well when we had - 2 members

- 3 to 5 members
- others

PART C: Please answer the following questions:

21. Do you like this learning approach? - Yes - No - Undecided

Please present your reasons.

22. Please tell the good points and the drawbacks of the format of cooperative learning in this course.

23. What do you suggest for improving if we continue to work as groups?

APPENDIX G

OBSERVATION AND VIDEOTAPING SCHEDULE

Day	Observation	Videotaping
September 24	Group 4	
October 2	Group 2	Group 4
October 8	Group 6	Group 5
October 12	Group 3	Group 6
October 19	Group 1	
October 26	Groups 4 and 5	

APPENDIX H

RESPONSES TO CLOSED-ENDED QUESTIONS

(Results were showed in terms of percentage of the responses)

Total of students in the class: 27 (11 females 16 males)

Total of returned responses can use: 23 (9 females 14 males)

PART A: A: Agree DA: Disagree UN: Undecided, or not sure

	(%)	A	DA	UN
1. I usually tried to prepare the answers of the problems before the group work periods.	78	4	17	
2. I felt comfortable when telling my confusion and discussing with group-mates.	91	0	9	
3. I was willing to explain things to help my friends be aware of the problems.	91	0	9	
4. I rarely asked group-mates to know if they really understood the problems.	13	35	52	
5. I rarely asked others who did not voluntarily participate in the group work.	9	43	48	

6. I solved myself again the problems after the group work periods to insure my understanding.	61	13	26
7. I felt isolated in my group.	0	91	9
8. I did not like to hear group-mates present the answers that I already knew.	4	87	9
9. Group work encouraged me to study every week.	70	13	17
10. Questions of my friends made me think the problems more deeply.	91	0	9
11. Working in the group helped me understand the problems better.	96	0	4
12. Discussion with friends helped me overcome my confusions.	70	4	26
13. Group work periods were waste of time.	0	83	17
14. I prefer the answers of the teachers to discussion with group-mates to find out the answers.	22	22	56
15. I like to continue to solve the problems in small group in the rest of the course.	74	4	22
16. I like more opportunity to work in small groups in other courses.	65	0	35
17. Studying in heterogeneous groups is ineffective.	0	52	48

PART B:

18. In order to prepare for group work periods, I usually:

- try to solve the problems myself 39% (*)
- sketch the answers of problems 30%
- glance over the content of the questions 22%
- do nothing 0%
- others 9%

19. I studied a week for this course at home.

- under 1 hour 0%
- 1 to 3 hours 65%
- more than three hours 35% (**)

20. I felt my group worked well when we had

- 2 members 9%
- 3 to 5 members 87%
- others 4%

PART C:

21. Do you like this learning approach?

- Yes 82%
- No 9%
- Undecided 9%

Note: (*) 67% of the female in the class – 21% of the male in the class.

(**) 67% of the female in the class – 14% of the male in the class.