CHAPTER VII

CONCLUSIONS AND RECCOMENDATIONS

In this chapter, an overview of the study, research conclusions, and recommendations are presented.

Overview of the Study

The aim of the study was to find out how to help disadvantaged high school science students in welfare schools of Thailand to learn genetic concepts and communication skills using genetic instructional units based on a social constructivist view of learning. The purposes of the study were to answer the research questions as follows:

1. What are the current situations of genetic teaching and learning to disadvantaged high school science students in welfare schools of Thailand?

2. What are the basic genetics concepts held by high school science students in welfare schools of Thailand?

3. How to develop Genetic Instructional Units (GIU) that helps disadvantaged high school science students in welfare schools of Thailand to understand genetic concepts and develop their communication skills?

4. What are the impacts of the Genetic Instructional Units (GIU), based on a social constructivist approach, on teaching and learning of disadvantaged high school science students in welfare schools of Thailand?

The study consisted of two phases. The first phase was to survey the existing situations of teaching and learning genetics for disadvantaged students by biology teachers in welfare schools and to survey the basic genetic concepts that

disadvantaged high school students held. The researcher used two questionnaires, which were *Teachers' Questionnaire Form* and *Students' Questionnaire Form* with 18 biology teachers and 129 disadvantaged students in 17 welfare high schools where there was a science program. The data was collected between September and October of the 2004 academic year. The data in the Likert scale parts were analyzed by percentages and mode. The data in the open-ended parts were read, categorized, and interpreted.

The researcher used the 'Basic Genetic Concepts Survey' (see detail in Appendix A), which included the topics: inheritance traits, gene, chromosome, dominant and recessive alleles, genetic diseases, sex chromosome, and genetic engineering with 157 disadvantaged high school students in 16 welfare schools in Thailand. The data was collected in November and December of the 2004 academic year. The data from the 'Basic Genetic Concepts Survey' was analyzed by read, categorized into four categories, which were scientific understanding, partial understanding, alternative conceptions, and no conception or no answer. Then, the students' conceptions in each category were analyzed by percentages and mode.

The results of the current situation of teaching and learning genetics for disadvantaged students and the basic genetic concepts which they held were used in developing the genetic instructional units.

The second phase was to develop genetic instructional units (GIU) based on a social constructivist view of learning, and to investigate the impacts of the genetic instructional units on high school science students' understanding of genetic concepts and communication skills in two welfare education schools in Bangkok and Nonthaburi province. The genetics instructional units were comprised of the topics of: DNA definition and significance, DNA discovery, DNA chemical components and structure, Invention of DNA model, Presentation of DNA model, Genome, DNA replication, DNA Transcription, Translation, Mutation, Genetic engineering, and Mini Molecular Genetics Fair. In case study school A, 23 Grade 10 students in a welfare school in Bangkok were taught molecular genetics by the researcher, who was a

biology teacher in the school. The instructional units were implemented in January 2005, the second semester of the 2004 academic year. In case study school B, 8 Grade 12 students in a welfare school in Nonthaburi province, a suburban area of Bangkok, were taught molecular genetics by a biology teacher in the school in February 2005, in the second semester of the 2004 academic year. The instructional units follow the science content standards in Basic Education Curriculum set by IPST (2001) and include course descriptions, lesson plans, and time schedules.

The data from each unit of the implementation of the GIU was collected by using videotape recording, cassette tape recording, students' journals, observer field notes, and teacher journals. The data from the 'Advanced Genetic Concepts Survey' was analyzed by read, categorized into four categories, which were scientific understanding, partial understanding, alternative conceptions, and no conception or no answer. Then, the students' conceptions in each category were analyzed by percentages and mode. Data on student genetic conceptions were triangulated by the 'Basic Genetic Concepts Survey', the 'Advanced Genetic Concepts Survey', videotape recording, cassette taped recording, student journal entries, teacher journal entries, and observation. Student communication skills were triangulated in the same way. The data indicated that in both cases disadvantaged students can develop their genetic concepts and communication skills through GIU.

Research Conclusions

The phase I genetic teaching and learning surveys showed that the teacher respondents taught genetics by a variety of teaching strategies. The main teaching strategy was teacher explanation mixed student presentation and teacher questioning to raise student thinking. Instructional materials were various but most came from student textbooks or a teachers' manual. Teachers assessed and evaluated student learning using test and practical sheets. The teachers said they would like to attend a professional development program to develop their teaching strategies and to help them create instructional materials. Student responses showed that they would prefer a variety of teaching and learning strategies. The students expressed a preference to

learn knowledge which they could use or link to their daily lives. When they had problems in genetics, they talked with more capable peers or teacher. In conclusion, the results showed that teachers and students had teaching and learning problems, which were: 1) students had low motivation and had limitations in learning genetics; 2) teachers had knowledge limitations about genetics; 3) the predominant teaching and learning strategies were teacher explanation with student presentation and discussion; 4) instructional materials were out of date; 5) the assessments were tests like the examination. These findings indicated a need to develop the teaching and learning of genetics for disadvantaged students with support for a social constructivist approach.

The phase I 'Basic Genetic Concepts Survey' results showed a variety of student alternative conceptions. The results showed that the majority of students had 'Alternative Conceptions' about genes, chromosomes, dominant and recessive alleles and genetic diseases concepts. They had 'Partial Understanding' about inheritance traits and sex chromosome concepts; and 'No Conception' in genetic engineering concepts. This presented the need to find some way to develop students' understanding in these scientific concepts.

According to the 1999 National Education Act of Thailand, there should be equity for all people in education. Moreover, the current learning reform of Thailand promotes teaching and learning strategies that encourage students to construct their own knowledge. Alongside this, the literatures showed that many educators have had success implementing social constructivist approaches when teaching disadvantaged students (Campione et al., 1994; Palincsar and Klenk, 1992; Mallory and New, 1994; Bloom et al., 1999; Graham and Harris, 1994; and Englert, 1992). The literature indicated that a social constructivist based approach can help disadvantaged students learning in an inclusive classroom.

The genetics instructional units (GIU) that were designed in phase II of the study were based on a social constructivist perspective to teaching and learning for disadvantaged students in the welfare schools of Thailand. The unit had two goals: to

develop the genetic concepts of disadvantaged students and to promote their communication skills.

From the Basic Genetic Concepts Survey of the students in the two case study classes, the majority of disadvantaged students did not have scientific conceptions. In school A, the majority of them in each genetic concept showed that they did not have scientific conceptions in any of the 7 concepts. Most of them had 'alternative conceptions' in genes, chromosomes, dominant and recessive alleles, genetic diseases, and genetic engineering concepts; and 'partial understanding' in inheritance traits and sex chromosome concepts. The majority of disadvantaged students in school B did not have scientific conceptions in five concepts out of seven. Most of them had 'alternative conceptions' in inheritance traits, genes, chromosomes, genetic diseases, and genetic engineering concepts; and 'partial understanding' in inheritance traits, sex chromosomes, and genetic engineering concepts.

The results from implementing GIU in both two cases showed that genetic concepts of disadvantaged students were developed. To implement the GIU in an effective way, the teachers had to prepare themselves both knowledge and pedagogies before coming into the class. The teacher in school A realized that she should learn hand language in case that she had to teach hearing impaired students. The hearing impaired student could not understand some words; even he was able to hear it. The teacher in school B realized that she should find time to revise teaching and learning theories and new strategies to improve her teaching. In conclusions, to implement the GIU in each school, teachers should adapt some parts or activities to suit for the genetic prior knowledge. The researcher realized that the ordering of teaching and learning in each grade was importance to students' understanding. For example, when the teacher in school B knew that the students had alternative conceptions about chromosomes, she started the lesson by turned on videotape of cells and chromosomes, before following the instructions of the unit in GIU.

In conclusion, teaching genetics for promoting genetic concepts for disadvantaged students should take into account the following: 1) check students'

prior knowledge (Gray, 2005); 2) scaffolding student learning by creating flexible, meaningful and culturally relevant activities with practical instructional materials, and using dynamic assessments (Palincsar, 1998; Kiraly, 2000; and Bauer et al., 2001); 3) believing that every student can develop their own understanding; 4) using daily life issues which raise student's motivation, such as the examples of Unit 10 in Chapter 6; 5) connecting the concepts, following the method of easy to difficult concepts, such as the examples of Unit 3 in Chapter 6; 6) setting seating position so that hearing impaired students can see the teacher's mouth, which is related to Division of Disability People (2000: 14, 102, 117, and 119); 7) grouping students in small mixed ability cooperative groupings and cross-sex and mixed ability parings (Schwartz, 1987); 8) using instructional materials which are easy to find, easy to use and understand, can be used in a variety of activities, and are inexpensive and durable. This is related to the policy of teaching for disadvantaged students (Division of Disability People, 2000: 14, 102, 117, and 119); and 9) studying students' educational, physical, and mental backgrounds. In addition, a teacher should use 1) understandable activities which move from easy to difficult concepts; 2) practical instructional materials; 3) grouping techniques; 4) periodically dynamic assessments and; 5) study the limitation of student communication skills individually and also promote students' communication skills. Most of participants could use language as an important tool to develop their understanding in genetics through social interaction in the GIU classrooms.

The 'Advanced Genetic Concepts Survey' was used to explore the advanced genetic concepts held by disadvantaged high school science students in welfare schools A and B (see detail in Appendix B). In school A, from the results of the 'Advanced Genetic Concepts Survey', most of the students had 'Scientific Understanding' in DNA function, chemical components of DNA, genome; 'Partial Understanding' in nucleotide, DNA structure, DNA replication, DNA translation, mutation, and genetic engineering; 'Alternative Conceptions' in DNA transcription; and 'No Conception' in DNA position. In school B, most of the students had 'Scientific Understanding' in DNA function, nucleotide, genome, mutation; 'Partial Understanding' in chemical components of DNA, DNA structure, DNA replication,

DNA transcription, DNA translation, and genetic engineering; and ‘No Conception’ in DNA position.

In both cases, the results showed that the GIU helped the disadvantaged students in Thai welfare schools understand advanced genetic concepts through a variety of activities that involved social interaction, such as inquiries, hands-on activities, investigations, small group discussions, and whole class discussions. The students as active learners had to: 1) help their group doing a variety of activities; 2) hold discussions among peers or with their teacher; 3) answer the teacher’s questions; 4) set questions for finding ways to investigate the answers. The GIU also encouraged students to develop their communication skills through activities such as the presentation of a DNA model and a molecular genetics exhibition. In school A, the GIU promoted disadvantaged students’ communication skills through inquiries, small group activities and whole class discussions. For instance, during the unit, an autistic child who had problems in communication volunteered to read in front of the class. In school B, all students had little confidence in their Thai accent because seven of them were from hill tribes and eight did not speak Thai in their family groups. From the variety of learning activities in the GIU and with some encouragement from the teacher and the researcher, they were able to develop their communication skills and to present their ideas both in their groups and in a school exhibition. In conclusion, the disadvantaged students had to 1) begin to speak out about their ideas in small groups before moving onto a whole class discussion or a discussion with the teacher; 2) have confidence to ask questions when they could not follow the class; 3) make contributions to group artifacts; and 4) develop their writing through their journals or through using the whiteboard.

Recommendations

From the study, the researcher had the following recommendations for 1) teachers who have to teach disadvantaged students; 2) science educators who have to deal with the students and the teachers and; 3) policy makers.

1. For teachers

1.1 To teach genetics for disadvantaged students, one has to link concepts with their students' daily lives. To see the relationship between the knowledge the students are learning in class and the potential benefits of this knowledge in the social situations of their daily lives are important to the students' intentions and understanding.

1.2 To check students' alternative conceptions and check students' prior knowledge before teaching allowed the teachers to better develop student understanding. This study provides a number of methods that teachers might use to develop students' understanding before moving onto new concepts. Teachers would also benefit from professional development when studying these methods.

1.3 While the GIU were successful in the two cases described here teachers should be encouraged to revise and refine it so that it is suitable to their students. For instance, the teacher in school B added a videotape of chromosomes for students once she reviewed the Basic Genetic Concepts Survey results and realized that her students had problems in understanding chromosomes.

1.4 It is important that teachers understand the purposes and process of GIU implementation. Implementing the units with understanding is likely to be more useful for both the teacher and the students in the long term. Once a teacher has understood the principles of social constructivism embedded in the units it would seem to be more likely that the teacher would develop others topic units in the same way by her or himself. Hence, it is recommended that professional development accompany the dissemination of the units.

1.5 The social interactions among peers and between the teacher and students could contribute to the students' learning of genetic concepts through the GIU.

1.6 Teaching genetics for disadvantaged students needs understanding from the teacher, not only of genetics knowledge but also the background of their societies. Teachers should believe in the potential development of their students. This is according to the 1999 National Education Act and the 1997 Constitution of Thailand, which emphasize the need to develop all people to fulfill their capabilities. However, according to the social constructivist approach as per Vygotsgy's perspective, everybody can develop their learning through social activities with more capable peers. Teachers have the responsibility to promote disadvantaged students' learning by checking students' prior knowledge, connecting concepts, using a variety of teaching strategies (including having mixed ability and mixed genders in each group), and using dynamic assessments.

2. For Science Educators

2.1 The advanced genetic concepts survey should be used with students in other welfare schools at the same time. Each welfare school may have specific variables which can affect students' conceptions in genetics.

2.2 The GIU should be implemented into other welfare schools where students have similar characteristics, such as those who have limitations in communication skills or those who are financially poor, are orphans, are from separated families, or have intellectual disabilities, autism, or are hearing impaired. One should study the implications of using GIU, particularly on how they affect the students' genetic conceptions and communication skills.

3. For Policy Makers

3.1 The teacher who teaches genetics should have a background in biology. The results of Chapter 4 showed the problems in teaching and learning genetics when the teachers graduated from mathematics but had to teach genetics.

3.2 The teacher who has to teach genetics for disadvantaged students should be able to communicate with the students and have knowledge in special education.

3.3 The disadvantaged students may have different goals in their lives according from their financial, physical or mental limitations. Thus, the educational goals in learning genetics may differ from the average student. The policy maker should be concerned about the disadvantaged students' needs and goals in education, rather than trying to push them to accomplish the national goals for average students.