CHAPTER I

INTRODUCTION

Significance of Study

The 1997 Constitution of Thailand state that it is the right of all Thai citizens, irrespective of race, language, gender, age, physical or health condition, personal status, economic or social standing, religious beliefs, education and training, or political views, to have a good quality of life and the ability to depend on themselves (Office of the Council of State, 1997). Education is one of the important public services which can help people to develop their own capabilities. The principle of education in Thailand, as set out in the National Education Act of Thailand in 1999, is based on the belief that 'all learners are capable of learning and developing themselves' (Office of the National Education Commission, 2002).

Thailand is one of many countries which are seeking to enhance the quality of learning and teaching for students and teachers by introducing learning reform. The national education reform in 2000, which is according to the 1997 Constitution of Thailand and the 1999 National Education Act in Thailand, seeks to promote the ability of Thai children to develop their full potential and creativity (ONEC, 2000; Fry, 2002: 37). The rationales of the reform are to serve the needs of learners and to serve in harmony with learning culture in the age of globalization (ONEC, 2000: 4-7).

According to the Basic Education Curriculum in 2002, genetics is in Content 1 'Living organisms with living processes' of science section. In science content standard 1.2, students should have ability to describe and discuss the genetic transfer process, variation, mutation, and the cause of biodiversity (IPST, 2002: 5-9). From the standard, it presents the importance of genetic concepts and communication skills in learning genetics.

Genetics is an important base for understanding a number of topics in biology, such as evolution and biodiversity and so it is an important content area in biology education. It plays a key role in the impact of biology on society and every student should know something about genetics (Browning & Lehman, 1988: 748; Davis & Weller, 1996: xiii; Hartwell et al., 2000: xix). People need molecular genetics knowledge and values in order to be able to make appropriate decisions about controversial molecular genetics issues in environmental education and healthcare education, and also to communicate their molecular genetics knowledge and values to others.

In our global society, the importance of molecular genetics knowledge is recognized as having two aspects: societal and educational. In the societal aspect, molecular genetics knowledge is a key part of the new knowledge-based society. It has some direct and indirect impact on social controversies, and is presented in a number of media. These media, such as magazines, television programs, and films show how molecular genetics can improve the quality of people's lives e.g. for diagnosis of some diseases in medical development and use in forensic science. Lemonick (2002: 56), Kluger (2002: 18-25) and Stolze (2002: 45) are international journalists who reported on molecular genetics topics. Popular television series, such as *Crime Scene Investigation* (CSI) and *Special Victims Unit* (SVU), which are broadcasted in many countries, are examples of how genetics is included in "real-life" situations. In Hollywood movies, e.g. *Gattaca,* have explored issues related to genetic engineering; such movies have a powerful and unpredictable influence on public perceptions. The debate about how to use the knowledge of molecular genetics is a key debate in the twenty-first century. The ability to debate molecular genetics values, for instance, the use of genetic engineering for modifying some plants, or for treating some diseases, should be a key component of genetics education.

In the educational aspect, molecular genetics knowledge is a major topic in the biology curriculum of many countries and an important part of learning reform in science education (National Research Council (U.S.), 1996: 106; National Science Teachers Association, 1996: 84-92, 98-105; Ministry of Education, 1997: 64-69;

Institute for the Promotion of Teaching Science and Technology (IPST), 2002: 3-9). Genetics at high school level constitutes a large part of the biology curriculum and many students had alternative conception in genetics. Genetics takes up more than half the time allocated to biology during the semester in Thai curriculum. Molecular genetics includes the contents of genetic characteristics, discovery of genetic knowledge, chromosomes, genes and chromosomes, genetic materials, characteristics of genetic materials, DNA in prokaryote and eukaryote, mutation, and genetic engineering (IPST, 1998: 1, 75, 108; IPST, 2000).

A number of research studies have examined the difficulties encountered in genetics education, and alternative conceptions in genetics held by students. In New Zealand, Wood (1996) described how students, especially at senior secondary level, described their learning in genetics as "hard; too much to remember; too long a topic; too many different parts to it; was confusing" (p. 1). Wood found that "students' understanding of genetics lacked the cohesion that reflects meaningful learning" (p. 1). In Thailand, Sukpimontree (1988) and Mungsing (1993) found alternative conceptions of genetics in Thai students. Sukpimontree reported that students in Grade 11 of Surat Thani province had high alternative conceptions of polygenes, multiple alleles, monohybrid cross, dihybrid cross, inheritance traits, heterozygous gene, homozygous gene, incomplete dominance, and inheritance and environment. The students had few alternative conceptions of dominant and recessive traits. Mungsing identified students' alternative conceptions of molecular genetics in Khonkaen province, which were the equality of genetic contribution of each parent in sexual reproduction, genetic characteristics, genetic variation, dominance, recessive, dominant gene, phenotype, monohybrid cross, dihybrid cross, allele, incomplete dominant, multiple genes (polygenes), gene and chromosome, and linked gene and gene recombination.

Disadvantaged students are children from particularly difficult circumstances who have had their rights violated; who live on the streets; are prostitutes, orphans or abandoned children; have been attacked; are detained in a house of correction; are drug addicts; have severe diseases or of parents having the diseases; are poor; are of

minority groups; or are gifted children (Office of the National Education Commission, 2000: 7-11; Welfare Education Division, 2000: 13-15). One of the social factors common to children in this group is poverty (Pallas, 1989: 2), which is widespread in many parts of Thai society. In Thailand welfare schools provide education for disadvantaged students including special needs students or learning disabilities students in the regular classroom, which are then referred to as inclusive.

Data from the Welfare Education Division, which is a government unit that has responsibility to look after disadvantaged students in welfare schools of Thailand, indicates the grade point average of students in science including biology is low, approximately grade 2 in the four grade system (Welfare Education Division, 2000). However, disadvantaged students need to be able to learn genetics following the science content standard just like other students in Thailand.

The Thailand learning reform encourages teachers in each school to develop their own school based curriculum, which is suitable for students in their school. Likewise, the Welfare Education Division (2000) requires welfare schools to use an approach in teaching and learning science which is based on the needs and abilities of their disadvantaged students. The welfare division policy schools need "to develop and promote teaching and learning science and technology for relating to the up to date knowledge and students' needs" (Welfare education division, 2001: 15-16). The Thai reform also encourages teachers to use instructional approaches and instructional materials which can promote student understanding with an emphasis on using a student-centred approach (Wasi, 2000: i).

Social constructivism is a learning theory which acknowledges students' prior learning and focuses on students constructing their own knowledge through social interactions with more capable peers and or the teacher (Driver and Oldham, 1986; Vygotsky, 1978: 86; Howe, 1996: 42, 48; Palincsar, 1998; Kiraly, 2000; Bauer et al., 2001). The social constructivist approach has been proposed as a way to support students with learning disabilities (Harris and Graham, 1996; Mercer et al., 1996). Englert (1992) identified students' learning development in communication using a

social constructivist approach for learning disabilities students. To teach disadvantaged students in inclusive classroom, teachers should use a number of flexible teaching techniques, such as small mixed ability cooperative grouping and cross-sexed with mixed ability pairing (Trowbridge et al., 2000). From Vygotsky's point of view, the development of special needs children is determined by the social implications of their impairment (Kozulin et al., 2003: 1-11). Vygotsky's ideas for addressing this included the development of social conditions to help student learn in inclusive classrooms in way consistent with the student-centered approaches recommended in the National Education Act (B.E. 2542) of Thailand.

Some of the factors that can affect the scientific conceptions of students are the teaching strategies and instructional materials used in the science classrooms. A number of researchers have examined genetics teaching strategies and instructional materials that affect the development of student understanding and scientific concepts. Pashley (1994) found that using chromosome models promoted students' scientific concepts of gene and allele relationships. In Thailand, Mungsing (1993: 169-170) found that a cooperatively-designed teaching approach promoted students' scientific concepts of genetics. From the researcher's teaching experience in Thailand, the students in welfare schools had difficulties in learning molecular genetics, particularly at high school level. The causes could be teaching strategies and instructional materials, which need for research to find the actual causes and to help teachers teaching and students learning in this area.

In today's society, people not only need to have knowledge and understanding of key molecular genetics concepts, but also the ability to communicate their ideas about these concepts to others, and to make decisions in what is a values-laden area. This is because genetic knowledge is widely used to improve the quality of people's lives (Laosuwan, 1996: 1-4). Disadvantaged people also need to be able to discuss genetics ideas and to understand their implications. To produce citizens with these abilities, there is a need to develop molecular genetics instruction units which are appropriate for disadvantaged students in that they recognise the students' prior

knowledge and alternative conceptions. And in order to do this, the researcher as a teacher and teacher-educator need to know how genetics is taught in the present-day.

According to the limitation of research findings in genetics education with disadvantaged students in Thailand, the researcher recognises the particular importance of learning and teaching molecular genetics to Thai disadvantaged students in welfare schools: these students come from disadvantaged backgrounds but they have to reach the same science content standards as average Thai students. This is the entry point for developing the Genetic Instructional Units in this study which should have the potential to be useful in the wider Thai education for disadvantaged students. An understanding of the teaching and learning of genetics by disadvantaged students will be of benefit for teachers and science educators who work with other students who have difficulty in learning genetics. Understanding genetic concepts and having the ability to discuss social issues involving them will help students to live happily in an ever changing world, which is one of the objectives of learning reform in Thailand. The aim of this 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 approach.

Research Objectives and Questions

The objectives of this research are as follows:

1. To examine the existing situations of teaching and learning genetics of disadvantaged high school science students in welfare schools of Thailand;

2. To explore basic genetic concepts held by high school science students in welfare schools of Thailand;

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

4. To study 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;

According to the objectives above, the research questions are as follows:

1. What are the current situations of teaching and learning genetics 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?

Anticipated Outcomes

From the findings of the research study, the following outcomes are anticipated:

1. The research may provide an effective teaching approach for biology teachers in welfare schools who are interested in discovering a variety of instructional strategies for developing disadvantaged students' existing knowledge about genetics;

2. The research may illustrate for science teachers how to develop or organize effective instructional units in genetics for disadvantaged students;

3. The research may be a guideline for science educators to teach science teachers how to develop effective genetic instructional units.

Delimitation of Study

The subjects of the study were composed of biology teachers and disadvantaged students in welfare schools of Thailand, where genetics was taught in high school science program. The number of the biology teachers and disadvantaged students were different in each phase of the study. The first phase was to survey the current situation of teachings and learning genetics for disadvantaged students by biology teachers in welfare schools, the researcher used two questionnaires with 18 biology teachers and 129 disadvantaged students in 17 welfare schools where there was science program in high school. In the second phase, the 157 disadvantaged students surveyed were studying in 16 welfare schools in Thailand for basic genetic concepts survey. Then, two teachers in two welfare schools with 23 and 8 disadvantaged students. The contents of genetics were inheritance traits, gene, chromosome, dominant and recessive alleles, genetic diseases, sex chromosome, DNA function, DNA position, nucleotide, chemical components of DNA, DNA structure, DNA replication, DNA transcription, DNA translation, genome, mutation, and genetic engineering. The data was collected between September of the 2004 to February of the 2005.

The Genetic Instructional Units (GIU), follow science learning standards set by the IPST and include course descriptions, lesson plans (including concepts, objectives, teaching and learning activities, instructional materials, and assessment), and time schedules, were composed 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. The

GIU were implemented in two welfare schools in Bangkok and Nonthaburi province, where had teaching and learning genetics in the second semester of their school curriculum. The disadvantaged high school science students' understanding of genetic concepts, and communication skills were collected.

Operational Definitions of terms

Disadvantaged Students

Disadvantaged students are children in particularly difficult circumstances who are violated of their rights; live on the streets; are prostitutes, orphans or abandoned children; are attacked; are detained in house of correction; are drug addicts; have severe diseases or of parents having the diseases; are poor; are of minority groups; are gifted children; are intellectual disabilities children; are hearing impaired children; or are autistic children. Disadvantaged students in welfare schools receive free tuition, lunch, and milk. Most of welfare schools that students can learn in are free of charge.

Social Constructivist Approach

Social constructivism is a philosophy of learning which describes how people learn and construct their knowledge through participation with more capable peers and as a teacher. This philosophy recognizes that new understanding is a combination of prior knowledge and new information which active requires construction on the learners' part. A student's Zone of Proximal Development (ZPD) is the distance between the actual development level and the level of potential development when they work with a more expert other. Language is a tool in communication, which students can use in their learning development through social interaction for developing their potential development.

Teachers can scaffold student learning by creating meaningful and culturally relevant activities, using dynamic assessment, and using grouping techniques to

promote students' communication skills through social interaction. From social constructivist teaching perspectives of teachers need to build on students' prior knowledge, include opportunities for sharing and discussion of ideas and experiences related to students' everyday lives to interaction with teacher as a person more knowledgeable in science is vital.

Genetic Instructional Units based on Social Constructivism

Genetic Instructional Units based on social constructivism are the instructional units, which consist of unit objectives, content, learning activities, instructional materials, and evaluation procedures that help students to construct their own meaning through social interaction in genetics, and based on students' prior knowledge.

Students' Genetic Conception

Students' genetic conception is the ideas and understanding of students in genetic concepts which are presented by explaining the meaning, giving examples, using the concepts and linking to related concepts. The genetic concepts are concepts in the 2002 Basic Education Curriculum of Thailand, including DNA function, DNA position, nucleotide, chemical components of DNA, DNA structure, DNA replication, DNA transcription, DNA translation, genome, mutation, and genetic engineering.

Communication Skills

Communication skills are the abilities of students to participate with their peers and with their teachers, answer questions, write journal entries, present their knowledge or models, and discuss issues with their peers and teachers for learning in molecular genetics instruction units in the classroom.

Summary

The significance of genetics comes not only from its present importance in society, but also from its place in biology education. To live in today's world, people need genetics knowledge; the ability to make decisions on genetic topics which are related to their lives; and the ability to communicate their genetic knowledge and decisions to others. Genetics is an important aspect of the science curriculum and in the standards of the basic education curriculum of Thailand, which all students have to accomplish. Moreover, from the 1999 National Education Act of Thailand, everybody has equity in education. Disadvantaged students as members of Thai society have a right in education and to learn about science as set out in the content standards. This study places an emphasis on helping disadvantaged students who generally face a number of challenges in learning. Mallory and New (1994) suggested using a social constructivist approach to achieve an inclusive classroom that also includes disadvantaged students. The social constructivist approach has also been found to promote the writing skills of disadvantaged students (Englert, 1992). This study investigated the efficacy of a social constructivist approach in helping disadvantaged students learn genetics.

The significance of genetics education and the problems of teaching and learning genetics have been presented in Chapter 1 above. The second chapter, Review of the Literature, discusses the context of education in Thailand, disadvantaged students, social constructivist teaching and learning, genetics education, genetics conceptions, genetics alternative conceptions, communication and classroom interactions, and the theoretical framework of the study. The third chapter, Methodology, describes the research methodology, subjects, instruments, data collection, and data analysis approaches used in the study. The fourth chapter, The Existing Situations of Genetics in Welfare Schools of Thailand, sets out survey data on the teaching and learning of genetics in welfare schools in Thailand and details of the basic genetic concepts of disadvantaged high school students. The fifth chapter, The Development of Genetic instructional units (GIU), presents the guiding principles used to develop the units, and the development of the units. The sixth chapter, The

Results of the GIU Implementations and Discussion, presents data on the GIU overview, implementations of the GIU with two cases and describes students' genetic concepts after using the GIU. The seventh chapter, Conclusions and Recommendations, provides an overview of the study, sets out research conclusions and recommendations for the teaching and learning of genetics for disadvantaged students.