THE SOCIAL CONTEXT OF GENETICS EDUCATION IN VIETNAM: A CASE STUDY AT DALAT UNIVERSITY

by

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The Social Context of Genetics Education in Vietnam: A Case Study at Dalat University

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Abstract

There has been a call in science education literature for integrating science-related social issues into a science curriculum. The study of issues can help students to develop an understanding of science in a social context, to have some experience in making decisions on these issues and to develop positive attitudes toward science.

The purpose of this study was to develop and investigate an instructional design related to the study of issues surrounding human diseases and genetics as supplementary activities of a cell genetics course. A field trial of the design was developed for third year biology students at Dalat University (Vietnam) to investigate how they responded to the study of issues, specifically in terms of their learning of scientific knowledge, and about social issues, as well as their changing attitudes toward science.

Thirty nine students (18 females and 21 males) participated in the study during two months. Instrumentation included primarily a feedback questionnaire from students and a group interview with five students after the lessons. The secondary sources of data involved an attitude scale of students prior to the study, classroom observations, class and group discussions, students' writing reports and final essay, and two additional interviews with two teacher observers. Data from different sources were categorized and analyzed in general themes, using a descriptive style.

Findings of the study indicated that students showed interest in exploring science-related social issues, and appeared to enjoy studying in a cooperative context. Students had opportunities to reinforce and expand their scientific knowledge, and practice scientific reasoning.

By sharing their ideas, students were able to explore different perspectives on an issue, which reflected different beliefs, values, and conceptions. The study of issues appeared to motivate students to learn science, make them aware of the relevance of science, develop their communication skills and their relationships with teachers and other students.

Dedication

To the memory of my mother.

To my husband and our little daughters;

to our parents and sisters,

for their unending support, patience and understanding

during my studies at Simon Fraser University

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The Problem

Background to the Problem

In recent years, since the open door policy of the Vietnamese government, there has been a rapid economic growth of the country. Concurrently, educational reform has been perceived to be essential to meet the demands of a changing society. The Vietnamese government has undertaken remarkable efforts to upgrade education of the whole country. Innovations in both the nation's educational system and curricula from public to higher education have been established. In 1990, the former Ministry of Education, the General Department for Vocational Training, and the Ministry of Higher and Secondary Technical Education were fused together as one "Ministry of Education and Training."

In higher education, the expansion and restructuring of the educational system has led to a greater diversity and ability among those entering university. Students who pass the university entrance examination with high scores are accepted as scholarship students. Students with lower scores are accepted as tuition-paying students. The scholarships are re-allocated to the most successful students at the end of each semester of study. The academic programs are reorganized and broadened into seven basic programs as curricular core, encompassing science, economics, social studies and foreign language, for the first two years of all Vietnamese universities. The "University Credit System" has been applied, thus enabling improved access to a general higher education, particularly in the more remote areas of the country. The national incentive to upgrade the educational system led to the development of a plan in 1990 to restructure post-secondary science education in Vietnam, and to the formation of a consortium of eleven universities to undertake the incumbent science curriculum development and teacher education. The intent is to develop a basic science education in the community colleges that will serve as a solid foundation for further study in applied sciences at the universities.

The undergraduate science programs consist of two stages. In the first two years, students take a core curriculum made up of courses in Basic Sciences and some elective courses in social studies, in terms of General Higher Education Program. Upon completion of the first stage, they acquire a Certificate of General Higher Education. At the end of the first stage, students have to pass an examination to be admitted to transfer to the second stage—a specialization in one or two areas (fisheries, agriculture, engineering, etc.) during a two to three year period to obtain a Diploma of Higher Education. Students who fail the examination can undertake technical or vocational training (MUCIA, 1995).

The broad purpose of this restructuring is to increase access to basic science education and, therefore, to improve the scientific and technological literacy of the Vietnamese citizenry. Scientific literacy implies a broad, functional understanding of science and its applications to social experience (DeBoer, 1991). According to the National Science Teacher Association (NSTA), the theme of scientific literacy is identified as the most important goal of science education in North America during the 1980's and 1990's:

> The goal of science education during the 1980's and 90's is to develop scientifically literate individuals who understand how science, technology, and society influence one another and who are able to use their knowledge in their everyday decision-making. The scientifically literate person has a substantial knowledge base of facts, concepts, conceptual networks, and process skills which enable the individual to learn and think logically. This individual both appreciates the value of science and technology in society and understands their limitations. (Yager, 1990, p. 44).

In a review concerning reform in higher education in Vietnam during the "renovation" period, Le Thac Can (1991) points out:

> The task of higher education is not just confined to the supply of scientific and technical manpower to society, it is also designed to meet the demand of people to receive scientific and cultural education. (p. 173)

The problem of designing and developing university science courses that are capable of achieving the stated goals is still a great challenge. There is a need to develop a science curriculum and program of studies that reflects the true nature of the scientific enterprise, the interrelations among science, technology and society, as well as the historical and philosophical bases for scientific theories and achievements. In addition to these general characteristics, the curriculum must be appropriate to the Vietnamese context, being responsive to the unique needs of individuals and of society, and, at the same time, reflecting effective trends in science teaching today.

For the past twenty years, Vietnam has been somewhat isolated from the professional science and science education communities, and there is a feeling of urgency to "catch up" with the science of the developed world. So far, the idea that the science disciplines should be studied largely for their own sake has been predominant in science education. The general approach in science education has been to develop the "basic" knowledge of students, then to apply this knowledge to problem solving in certain applied or technological areas. Accordingly, the curricula have been heavily content-dominated. Hill (1986) comments:

> This presentation of science as a finished product was dogmatic and largely abstract, but claimed to provide an essential component of a cultural heritage and to have a specific problem-solving potential, essential in an industrialized society. (p. 112)

In addition, courses are designed primarily around a lecture approach, due to the poor conditions of laboratories. Students have few opportunities to actually practice science by doing experiments. Commonly, lab exercises are designed in a form of verifying the scientific principles presented in the curriculum, rather than of developing science inquiry skills. As a result, students often form an erroneous conception of the "scientific method" and "problem-solving". Study and assessment are based primarily on rote memorization and routinization. This problem is further exacerbated by the opinion among teachers that science remains "pure" in science courses; there is little space for problems related to the social nature of the scientific enterprise, or of human needs in the science-related aspects of our society. Most of the topics are designed to teach only the scientific principles involved.

The applications of science were addressed to students as illustrative information rather than revealing the impact of science on society that generates controversial problems in society. In general, the traditional curriculum is estimated "too academic".

In modern society, the impact of science and technology on human life is more pronounced than ever before. While advances in science and technology have potential for improving the quality of life, they also generate many social problems. As the twenty-first century approaches, the issues confronting humanity are increasingly complex and diverse. The expansion of industrialization and agricultural technologies has led to increased danger of air, water and soil pollution due to waste products, and to a global warming problem. The over-exploitation of natural resources has led to deforestation and associated deterioration of the planet. Discoveries in recombinant DNA technology have staggering potential benefits for medicine, agriculture, and industry, but simultaneously can create potential risks, including ecological and social disruptions. An understanding of science in relation to its applications and social relevance is required for wise solutions to be found. Such an understanding paves the way for curriculum reform from primary to higher education and foreshadows alternative but effective teaching approaches in the sciences.

In the new context, science curriculum based solely on the structure of the discipline has proved to be unsatisfactory, and therefore, it needs to be revised. The curriculum should introduce students not only to the basic principles and processes of the sciences, but also to the social context in which science is developed and applied. Henderson and Lally (1988, p. 145) insist that science must now include "technological applications and social, economic and environmental issues," and an awareness that "science is a co-operative activity, subject to social, economic, technological, ethical and cultural influences and limitations" should be promoted both among science teachers and students. To this extent, science should be taught in a personal and social context, making provision for students to deal with science-related social issues, practice critical thinking and problem solving skills through investigating these issues, and to make reasonable decisions. In the end, the study of science-based social issues can help students bridge the gap between principles and theories and the real world.

It is obvious that a content-dominated teaching approach is too narrow for the goals of scientific literacy that have been described above. It is not enough to present the social issues and to show their consequences. Science is a way of understanding—explaining and predicting—the natural world, and it involves the construction of knowledge in a "hypothetico-deductive" logical system. Further, science is a human endeavor to explain events in meaningful and relevant situations. The curriculum should provide opportunities for students to understand and apply the processes of science and problem-solving strategies in relevant contexts of inquiry. It is time to move from the content-oriented approach toward an activity-based approach, in which issues related to social, technological, and cultural settings in which science occurs are considered to be part of the subject medium. This trend in the teaching of science will assist educators in approaching the broad aims of science education for the future, namely to embed the learning of science in meaningful and relevant contexts that lend to the development of an informed and scientifically literate society.

Vietnam is interacting with other countries broadly and, as a result, it is experiencing economic growth and social changes. In the new context, education is recognized as a crucial element in the development process of the nation. One of the pressing needs is to develop balanced and relevant curricula as well as suitable teaching approaches in schools and universities. This is a broad and long-term program, requiring collaborative efforts and contributions from administrators, university educators, school teachers, students and their parents. It requires sustained inquiry into current understandings in science and the development of scientific knowledge, into the nature and needs of a developing society and culture, and into the personal interests, backgrounds and social needs of students.

In innovations in tertiary education, Dalat University where I have been working, has developed diverse academic fields and broadened cooperation with the other universities in the area. In response to the multidisciplinary model, the university has made great effort to construct available curricula based on the core programs identified by the Ministry of Education and Training, with participation of specialists and instructors. During the process, a set of problems is under inquiry: goals of education in the context of a changing society, content of the courses and materials, assessment techniques, and teaching methods. To contribute to the development of my institution, as an instructor and a member of the community, I set out to explore and apply an alternative approach to traditional teaching to my work.

I have taught genetics for ten years at Dalat University. What students learn about genetics involves basic concepts and principles, solving exemplar problems on inheritance, and the applications of genetics to medicine, agriculture and biotechnology. The social issues generated from advances in genetics are ignored for reasons dealing with the controversy of issues, with ethics and values being perceived as beyond the domain of science. Furthermore, as a science teacher, I did not realize that the study of issues implied a potential of teaching students about problem-solving skills. Having opportunities to explore current trends of western science education, I perceive that the "issues" approach is one of the beneficial ways to improve science teaching. I believe that incorporating social issues into science curriculum can help students learn science in a meaningful way, experience problem-solving and decision-making skills, and stimulate their interests in science. By engaging students actively in their learning, I hope to give them opportunities to learn in a co-operative context. In the end, students may gain an authentic view of science, not as a structure of the discipline but also a human activity embedded in a social context.

Statement of the Problem

The purpose of this thesis is to study the application of an approach of integrating socioscientific issues into biology education in an attempt to relate science to everyday life and engage students in their learning actively. I intended to develop an instructional model with a focus on social issues as an integral part of a cell genetics course for third-year biology students at Dalat University. A case study of the application of this model in a classroom setting provides opportunities for the author to investigate the potential of the approach, mainly using "qualitative" methods of research.

Specifically, the problems posed in the study are:

1. Designing four topics with a set of learning activities related to issues of human diseases and genetics; as supplementary lessons in a cell genetics course for third year biology students;

2. Investigating how students respond to social issues in the context of the cell genetics course, in which the following concerns are examined:

   - how they deal with the issues;
   - how they learn basic knowledge in cell genetics;
   - how their attitudes toward science change.

Significance of the Study

As a trial model for integrating social issues into science curriculum in the area of genetics, this study will provide some information contributing to the curriculum reform movement at my university. Generally, the study may give some helpful signals for science educators to modify the goals of science education as well as the science curriculum, to enable the presentation of science in its social contexts. The study of social issues may assist students in improving their understandings of basic science knowledge, while developing a better understanding of how science, technology, and society interact. Getting involved in problem-solving activities, students may be better prepared for life and their future careers and may develop a positive attitude toward studying science. The study may also encourage teachers to seek more effective teaching methods while broadening the content of the curriculum, rather than to use only didactic teaching, and restricting courses to basic principles and theories. Hopefully, the study may inspire teachers to develop their own curriculum, relevant to the classroom context with which they deal.

Limitations of the study

The study is limited to a local context and a small sample of students in a single classroom. The results, therefore, cannot be generalized on a large scale. Further, the study is both limited and enriched by the fact that the researcher is conducting the study in the context of her own classroom and curriculum. Some insider's views cannot be avoided due to the personal nature of the investigation, but will have to be acknowledged to the best of the researcher's ability. Finally, the study is limited by its rather short duration of two months. The data may be deeper if the period of field testing were longer, and if various teaching strategies were investigated under more varied conditions.

Organization of the Thesis

The thesis is organized into six chapters.

The background of the problem has been presented in the present chapter, giving an overview on the current educational reform in Vietnam and reason for undertaking the study. Chapter One has also included a statement of the problem, and posed the research questions. The significance and limitations of the study have been briefly discussed.

Chapter Two follows with an overview of science education reform and the Science-Technology-Society (STS) theme, from which a "social issues" approach is introduced. This approach is examined in terms of its aims and rationale, curriculum design and teaching strategies.

Chapter Three introduces the methodology of the study, including a description of the setting, an overview of the instructional design and development, a description of the instructional sequence, of instruments and procedures, and of the data analysis procedure.

Chapter Four addresses in detail the instructional design which was developed based on the logical-rational approach, including rationale, objectives, activity-based design and assessment plan.

Chapter Five presents the findings obtained from a field trial with third-year biology students at Dalat University, focusing on how students responded to the study of issues.

Chapter Six discusses about the findings in the previous chapter, indicates the limitations of the design in particular and the study in general, and suggests some implications in science education at Dalat University in the future.

Chapter 2
Literature Review

In this chapter, an overview of the history of science education reform in North America, in which the Science-Technology-Society (STS) approach was generated, is described in brief. From the position of STS, which is emphasized in science teaching in many countries today, the "social issues" approach, is examined in terms of its aims and goals, curriculum design and encumbent teaching strategies.

Science-Technology-Society (STS)

In relation to the development of science and society, the history of science education reform has been marked by three main periods, reflected in science teaching trends. During the first half of the Twentieth Century, a content-oriented approach was predominant in science education. Science teaching was concerned with rote memorization of facts and principles of the discipline. In the 1960's, curriculum reform focused on the educational values of scientific processes as inquiry. Due to progress in science and the involvement of research scientists in the development of science curricula, the aims and objectives in science education were reoriented. The primary goal was to prepare academic professional scientists, rather than to address personal, societal and career goals (Hill, 1986; Hart & Robottom, 1990; DeBoer, 1991). In biology, for example, curriculum was developed and logically restructured on the basis of core concepts and fundamental principles (e.g., the relationship between structure and function, the interrelationship between organism and environment), and the development of new subject matters (e.g., cell biology, biochemistry, genetics, ecology, evolution). Students were expected to learn and practice the way scientists think and work, and hence, to develop intellectual skills and positive scientific attitudes. The content of curricula tended to be academic, sophisticated, and was limited in terms of its relation to societal problems. In reality, the study of science for its own sake only motivated a minority of students who wished to pursue science as future careers. Other students felt science was difficult and not exciting (Yoong, 1987).

In the 1980's and early 1990's, science education has been oriented toward a science-technology-society theme, and emphasizes the impact of science and technology on society. Scientific literacy has been considered as a primary goal of science education (Hill, 1986; Hart & Robottom, 1990; Hofstein & Yager, 1982). Since 1980, educators have criticized the discipline-based curriculum in terms of limitations in meeting the needs of students and the demands of social developments. Advances in science have increased, and crucial applications in areas like medicine, agriculture and industry have undoubtedly much affected the social and cultural activities of human life, both positively and negatively. The interrelations between science, technology and society provide new challenges for science education. New scientific knowledge that reflects contemporary research and that generates problems related to human and social life came to be indispensable components of the curriculum (e.g., genetic engineering, protection of the environment, use of pesticides, health care, etc.). Therefore, there was a need for revising science education curriculum.

Science curriculum should be relevant to the majority of students as future citizens, not just those planning careers in science. Many educators have advocated incorporating the STS theme into science curricula, dealing with the interrelation of science, technology and society at all educational levels, from elementary to secondary and higher education (Hart & Robottom, 1990; Aikenhead, 1980; Wenham, 1992).

Such trends in science teaching have reflected the perception of educators about the nature and philosophy of science in relation to its social context. The structure of science includes at least two components—knowledge and process—which in fact, cannot be entirely separated. In the past, the science education of the 1950's represented an unrealistic image of science as a set of stable facts and principles. The science teaching reform movement of the 1960's focused on the nature of science as an inquiry process using scientific methods. The principle of the curriculum was to explain what science was and how scientific knowledge was generated, but it failed to address the social aspects of science. Therefore, science in school was "pure" and "hard," not necessarily aligned with students' interests or the needs of society. Science teaching of the 1980's was oriented to the latter requirements in combination with the scientific discipline, leading to a STS approach. The tendency was to teach scientific knowledge and processes in a context that emphasized the human and social concerns, thus it presented a more authentic view of science.

Generally, a curriculum based on the STS approach requires the integration of three factors: the needs of society, the discipline of science, and the needs and interests of the learner (Ramsey, 1993). As a consequence, the science curriculum should reveal a balance of process and content in a context of inquiry into social issues. Wenham (1992) clarifies:

> The policy of establishing a broad, balanced and relevant curriculum means that a balance must be developed between process, content and context in science education, with the aim of cultivating not only the expertise of the future professional, but also a critical awareness among all well-informed citizens of scientific activity and its implications. (p. 549)

For example, the Association for Science Education (ASE) in the United Kingdom advocated the view that "in addition to Pure Science (Science for the Inquiring Mind), there should be two other components in science education: firstly, Science for Action, and secondly, Science for Citizens" (Lewis, 1987, p. 59).

Ost and Yager (1993) quote the following definition of STS and its significance for science education, developed by the National Science Teachers Association (NSTA) in the Project Synthesis as a general view of the STS approach:

> STS is the term applied to the latest effort to provide a real world context for the study of science and for the pursuit of science itself. It is a term that elevates science education rhetoric to a position beyond curriculum and the ensuing debate about scope and sequence of basic concepts and process skills. STS includes the whole spectrum of critical incidents in the education process, including goals, curriculum, instructional strategies, evaluation and

> teacher preparatory performance. One cannot "do" STS by adding certain topics and lessons to the curriculum, course outline or textbook. Students must be involved with goal setting, with planning procedures, with locating information and with evaluating them all. Basic to STS efforts is the production of an informed citizenry capable of making crucial decisions about current problems and taking personal actions as a result of these decisions. STS means focusing upon current issues and attempts at their resolution at the best way of preparing people for current and future citizenship roles. This means identifying local, regional, national and international problems with students, planning for individual and group activities which address them; and moving to actions designed to resolve the issues investigated. Students are involved in the total process: they are not recipients of whatever a pre-determined curriculum or the teacher dictates. There are no concepts and/or processes unique to STS. Instead, STS provides a setting and a reason for considering basic science and technology concepts and processes. It means determining ways that these basic ideas and skills can be seen as useful. STS means focusing on real-world problems instead of starting with concepts and processes which teachers and curriculum developers argue in terms of usefulness to students.(p. 282)

It reveals that an STS approach focuses on individual learners as a part of society, with the primary goal of STS curricula being to prepare them to be scientifically literate and socially responsible citizens. Those future citizens should be able to make decisions about personal and social issues based on sound information and relevant scientific knowledge. Brinckerhoff (1985) argues that teaching the principles of science and its applications is not enough for the development of scientific literacy; social and ethical problems requiring value judgment and action should also be addressed to students so they can participate in solving these problems. Therefore, the curriculum should provide opportunities for students to engage in investigating and resolving real-world problems.

STS can shape the science curriculum in terms of reorganizing the science content to include themes of social relevance and student interest, the relationships between science and other areas of the curriculum, and the impact of science and technology on society. The many foci can involve science-related social issues, technology, the history and philosophy of science and technology and traditional content presented in a STS context (Ramsey, 1993). In general, these strategies replace the "coverage" of science content with selective content aimed at helping learners develop critical thinking and problem solving with respect to complex issues (Hart & Robottom, 1990; Ramsey, 1993; DeBoer, 1991).

The STS curriculum focuses not only on knowledge and intellectual skills but also feelings and emotions of people about the reality related to science around them. Value-laden issues provide opportunities for students to analyze controversial issues, based on scientific knowledge as well as their own beliefs and opinions. In general, the STS dimension is desirable to prepare students for the world of work and foster their personal development.

Ogens (1991) introduces a set of essential elements of a quality STS curriculum, including:

- Local and community relevance
- Applications of science
- Social problems and issues
- Practice with decision-making strategies
- Career awareness
- Cooperative work on real problems
- Multiple dimensions of science
- Evaluation concerned for getting and using information

More generally, Rosenthal (1989) distinguishes between the study of science through social "issues" and through the social "aspects" of science (e.g., the social-historical development of science, the social-cultural relationships of science). However, in practice, the social issues approach is predominant to STS education, while the social aspects of science are often revealed in the form of goals and objectives for STS education. There is an attempt to combine these two approaches, in which "broad goals based on some or all of the social aspects of science are stated as desired outcomes, while social issues are used as vehicles to achieve these goals as well as ends in themselves" (p. 587). It means that social issues can be used as vehicles for teaching the social aspects of science.

Social Issue Approach

Aims and rationale of teaching socioscientific issues

As mentioned above, integrating science-related social issues into a science curriculum is one of the foci of STS education that is designed to promote scientific literacy for learners.

In the present time, people have faced numerous advances in science and applications that contribute to the development of society and to improving the quality of life. For example, the techniques of recombinant DNA in genetic engineering expand our capacity to treat genetic diseases and to solve starvation problems in the world. The development of new fertilizers and pesticides in agriculture increases food production. On the other hand, scientific knowledge can also lead to severe hazards. For example, genetic engineering can be used to create biological weapons, toxins that harm human beings, crops, and environment. The overuse of pesticides leads to the danger of concentrating toxins in water, soil, and food. Many issues emanate from the impact of science and technology on society, such as those related to environmental pollution, drug testing, birth control and population growth, etc.

The benefits and risks of science and technology should be communicated widely in the general public. Having knowledge and understanding of the social issues is necessary for the public to participate in making informed decisions. Young people, as a part of society and future decision-making citizens, must be informed about science-related social issues. Hence, there is a need to design and develop a "science and society curriculum—based on the social context of the student and the role science plays within this context" (Aikenhead, 1980, p. 14).

Educators who advocate the "issues" approach attempt to organize social issues as themes of the science curriculum. Science related social issues involve problems based on science and technology, for which there are different beliefs and values and no absolutely right and wrong answers (Ramsey, 1993). For example, the issue of drug testing can raise different points of view related to the question of testing a new drug on human beings. This implies the controversial characteristics of the issues in terms of their applications or possible consequences in the social context. Dealing with social issues is multifaceted and requires drawing meaningful, well-thought-out conclusions (Aikenhead, 1980; Frazer, 1986).

Aikenhead (1980), in a discussion paper related to the study of Canadian science education, argues that to make rational decisions on socioscientific issues, students should understand the following points:

1. The characteristics of science, including its aims and values, its human character, and its strategies for decision making and extending knowledge;

2. The limitations of scientific knowledge, scientific values, scientific strategies, and scientific techniques, including the recognition that science is but one knowledge system among many in our society, and an examination of the boundaries between science and politics, science and economics, science and religion, science and technology, and science and ethics;

3. The characteristics of science and its place in society, including case studies of science related problems, and including personal interpretation of one's community by making decisions as a consumer, as a voter, and a career planning. (pp. 13-14)

It is obvious that the primary focus of STS education in general, and the "issues" approach to the teaching of science in particular, is to develop students' critical thinking and problem solving skills, involving analysis, assimilation, evaluation and decision making (Brumby, 1987). Ost and Yager (1993) argue that students can improve such abilities only when they are engaged in investigating a concrete problem. The reason is that the ability to transfer skill and knowledge to novel contexts varies greatly from person to person. For many students, it is difficult to apply scientific skills and knowledge abstracted from specific contexts (DeBoer, 1991). Issues are considered as vehicles to motivate students to learn science in a personal and social context. Surely, an understanding of basic and relevant scientific knowledge and the social world is essential to resolve the issue (Ramsey, 1993; Zoller et al., 1990). Students have opportunities to practice and apply scientific principles to typical life problems. Further, they get involved in investigating the issues with different viewpoints and value perspectives as well as clarifying their own viewpoints.

Learning social issues starts with problem identification, proceeds to problem resolution and involves students in decision-making. During the process, students need to seek out relevant knowledge as essential background for further reasoning, and offer explanations that promote human interaction. The interaction may include a discussion of the relative validity of various explanations, and consideration of the pros and cons of making particular decisions (Yager, 1987; Ramsey, 1993).

Indeed, students who are engaged in their own inquiry, practice scientific method and get a more complete image of science. They understand the characteristics and limitations of science, the relationships between science and society. They develop their personal views and recognize the value of others. They obtain new insights into scientific-societal problems and are aware that science is not value-free in its application, but interacts closely with human and social development (Henderson & Lally, 1988). They develop open minds and positive attitudes that can be translated into beneficial actions (Yoong, 1987; Brumby, 1987). In other words, the issue approach embraces both scientific and humanistic domains:

> An expectation of the humanistic approach to science education was that students would have an opportunity to examine what they thought and felt about value-laden science issues and would be able to communicate their values to others. Not only would the science that was taught be related to important social issues, but students would be given an opportunity to wrestle with moral dilemmas concerning those issues and would be given instruction in the valuing process. (DeBoer, 1991, p. 180)

Curriculum design

In order to achieve the goals of today's education, science curriculum should be designed around personal and social concerns. The focus on issues in curricula is used as a frame to train students to become scientifically literate persons in our changing society. Further, the curriculum does not neglect basic concepts and methods, but deals with in-depth selective subject matter instead of "coverage" of the discipline (Beisenherz, 1982). The question is how to integrate the relevant social issues into the curriculum, and to what extent they become the focus of instruction.

In general, Fensham (1987) defines three dimensions for social content of science education:

- The social nature of scientific work itself: science is an intellectual activity of human beings in a social context. Scientific knowledge is influenced by cultural and social factors and disseminated through communication.
- The social application of science: scientific knowledge applied in industry, in the social and personal life of human beings.
- The social ideology: the social application of science can be assessed as of positive or negative worth according to its implications to society - improving or reducing the quality of life. (p.70)

The level of interface of science and society presented in a curriculum can be varied according to the view of educators toward science education and the development of society. Before the 1960s, social content was put aside and "pure science" dominated in science teaching. From the 1970s, with increasing progresses of science and technology, the tendency of incorporating social content into curricula has increased. So far, the application of science to personal and social life has been emphasized. Further, together with problem-solving strategies, these three dimensions cannot be taught separately, and social issues, indeed, are available components of science curriculum.

There exist numerous approaches to teach social issues. Huppert et al. (1992) introduces two of these. The first considers science as a basic core curriculum, in which applications and issues related to appropriate topics of the course, are incorporated in the curriculum to "contextualise the concepts and principles taught" (p. 396). The body of scientific knowledge is thus enriched and made meaningful for students' learning. The second alternative attempts to structure the applications and issues first, based on which scientific knowledge is relevant and related to these issues. Yager (1987), a proponent of the "issue first" approach, emphasizes that social issues should function as central organizers for the science curriculum. The curriculum is problem-centered, and the organization of science is around socially relevant issues or problems, not around principles of science . Normally, the issue encompasses various disciplines, and knowledge, processes and skills from such disciplines are needed to solve the problems in an interdisciplinary way. For instance, in the study of public health, concepts and principles from relevant fields such as medicine, physiology, genetics, biochemistry and the social sciences are brought together. Some examples of course design reflect the pursuit of these perspectives:

- The "General Biology - audio-tutorial-independent study" developed at the University of Arizona (1972), based on the former approach, covered topics such as evolution of man, ecosystem concept, habitat concept, human physiology and disease, reproduction regulation, population, ecology (Unesco, 1977).

- Environmental science - an interdisciplinary and problem-oriented curriculum was developed for primary and secondary schools in the United States, United Kingdom, Philippines, Malaysia, African countries (Unesco, 1990).

- Chemistry in the Community deals with social issues as instructional organizers to motivate students to learn basic chemistry (Ramsey, 1993).

- The Science and Technology course for students of Grade 11 has been taught in British Columbia, Canada since 1987. The course was based on the exploration of contemporary social and technological issues (Zoller et al., 1990).

• Human Health and Science, an integrated STS biology course for comprehensive high school students, was organized into modules related to technology application topics and moral problems (Huppert et al., 1992).

Both approaches support critical views. Several educators criticize that integrating issues into the curriculum, in many cases, is just "repackaging" of traditional science content (Ramsey, 1993). Normally, a social issue goes beyond the limitation of a discipline and is impossible to simply add as a section of the traditional program. With the applications and issues first approach, science curriculum is organized around social issues rather than scientific principles. However, according to Kromhout and Good (1983), social issues as organizers would distract the science teacher from educating students in the structure and methods of science. Further, issues are contemporary. It means that when new social issues arise, the basic organization of science teaching should be revised. So, which is more relevant; fundamental principles of science, or a study of the issues themselves? Can students concurrently get an understanding of scientific knowledge and gain new insights into issues?

Most science educators applaud the use of social issues as effective vehicles for a coherent study of fundamental science, but feel they should not be used as central organizers for all science curricula and instruction (McInerney, 1989; Ramsey, 1993). It is necessary to prepare students for life, prepare them to be capable to solve the issues in science and society they will confront. However, "a monolithic issues approach for the various themes might not provide the most effective instructional mechanism" (Ramsey, 1993, p. 252). Therefore, a better perspective is that social issues should be part of school science programs to motivate students to learn science, both scientific knowledge and process. Bybee (1987) suggests the minimum amount of instructional time devoted to science related social issues in the curriculum:

Elementary school	10%
Middle / Junior high school	15%
High school	20%
College / University	25%. (p. 80)

A June 1980 conference in Exeter recommends that in either high schools or colleges, "replacing merely ten percent of current chemistry, physics and biology materials by ethical topics and problems would have a profound effect on student attitudes if it were consistently pursued, without necessarily subtracting from the more conventional material" (Brinckerhoff, 1985, p. 478).

In a traditional science course, teachers can modify the appropriate time to teach social issues, in practice, according to the context and learners. Teachers should be encouraged to develop their own curriculum materials and learning activities available to the teaching of social issues in their classroom. Collaborative work with colleagues and outside experts (doctors, farmers, industrialists, etc.) can contribute to the effectiveness of curriculum development (Yager, 1990).

An examination of the successful socially relevant programs that incorporate elements of action learning and issues-based instruction reveals that they involve students in investigating and attempting to resolve these issues. The structure of such programs includes a knowledge base, a skill component and culminates "in a component that applies the knowledge and skills to a real problem in a local context" (Ramsey, 1993, p. 244). Consider a Chemistry Curriculum in the Community as an example in which issues are central organizers of the course. However,

> ...considerable care has been taken to maintain the integrity of the chemistry that is included. The units are to be studied in sequence as later units build on chemical knowledge, skills and ideas introduced previously. Social science concepts are part of this curriculum, and they are introduced in a way that enables students (and their teachers in this novel area) to proceed from the comparatively simple to the more complex.
> (Fensham, 1992, p. 812)

Generally speaking, new orientations for science curriculum design involve constructing a balance of scientific content and process in a meaningful way for students' learning. Science knowledge and scientific inquiry are combined with activities that simulate decision-making on socioscientific issues. A selection of in-depth coverage of science topics is emphasized as a foundation for students to elaborate incomplete ideas, leading them to explore different alternatives and points of view (Eylon & Linn, 1988).

A further step is to identify which social issues should be incorporated into the curriculum. Based on the definition of a social issue, Ramsey (1993) emphasizes three essential properties required for a selected issue:

- there exists different beliefs and values about the issue,
- issues investigated should be of some social significance,
- issues should be related to either science or technology.

In relation to its significance to the community, Yoong (1987) analyzes the biological science in terms of three interrelated perspectives:

> The first is the social perspective, concerned with the relationship between biology and the socio-cultural dimensions of the community such as community nutrition and health, population and overcrowding. The second is the environment perspective, which deals with the impact of biology on the natural environment and the human ecosystem including natural resource management, ecological balance, conservation and pollution. The third is the global perspective, which is aimed at introducing "an awareness of the problem of world development and life of work, especially the situation faced by the world's developing countries and the part played by technology in creating problems. (p. 20)

From surveys of college students, science teachers, science educators, and scientists and engineers, Bybee (1987) reports the following problems to be ranked most important:

Air quality and atmosphere	Hazardous substances
World hunger and food resources	Human health and disease
War technology	Land use

Population growth	Nuclear reactors
Water resources	Extinction of plants and animals
Energy shortages	Mineral resources

It is obvious that the issue selected when designing a science curriculum should be relevant and suitable to the core of curriculum and its objectives. Moreover, it is crucial to study topics that are likely to have future importance for individuals and for society.

Ellis and Landes (1987) introduce a set of questions from Kennedy (1978) as guidance in presenting controversial issues in a science course:

1. Is the issue appropriate for the target group? It is generally agreed that a student's interest in a topic and selection of his or her own issue are desirable. The actual issue is identified from a general topic area. Newspaper articles can be helpful at this early stage. In addition, the study of an issue should be compatible with the students' background and experience.

2. Is the issue of significant societal importance? It involves social, economic and political problems that society encounters and needs wise decisions or even informed opinions based on careful investigation, applying scientific knowledge of citizens.

3. Will the study of the issue contribute to the overall goals of the biology program? The teacher should imagine how the objectives of the program can be achieved through the study of the issue.

4. Can adequate resources about the issue be provided for students, teachers and other people in the community? Printed materials, various media and knowledgeable resource people should be available for analyzing the issue at divergent sides.

5. Can student outcome related to the study of controversial issues be evaluated? Since the objectives focus on exploration of the issue rather than finding an answer to the issue, skills of information gathering,

analysis and evaluation should be reflected in the overall assessment of class activities such as debates, seminars or written report.

6. Can the issue be analyzed within reasonable classroom time? The issue should be carefully assessed because its inclusion may necessitate the exclusion of other topics from the curriculum. (p. 179)

Ellis and Landes (1987) illustrate several examples of science related social issues concerning health topics in the biology curriculum. Included are the global problems of world food supplies, societal and individual problems about the effects of smoking, alcohol or drug addiction, and issues around the use of birth control to limit human population growth.

Strategies for teaching social issues

Teaching strategies and learning activities should be compatible with the aims of the curriculum and based on an understanding about the learning process. Implementing a curriculum in which social issues are incorporated, calls for developing non-traditional, open-ended and problem solving teaching strategies, broadening the range of learning activities, and concurrently, constructing proper evaluation instruments on student perception and learning (Zoller, 1991).

It is obvious that the traditional teaching by "didactic" lectures is not suitable as the only or dominant strategy in teaching social issues. Students cannot make judgments by just listening or being told what opinions and beliefs should be (Frazer, 1986; Henderson & Lally, 1988). If used, direct teaching methods can be employed in a restricted sense to provide students with some overviews of factual and conceptual information and should be coupled with other strategies (Agne, 1986). Reiss (1993) considers three different approaches to the teaching of an issue. The approach of advocacy, in which the teacher supports his/her own view rather than students' views, may result in damaging student autonomy. The second approach is named affirmative neutrality, in which the teacher presents diverse points of view around the issue to students without addressing his/her position. Such a didactic activity, however, fails to motivate students to learn the issue and science. The third approach, procedural neutrality, involves the teacher, as a facilitator, in encouraging students to elicit their own opinions in the form of resource material. It is recognized that the success of the approach requires a careful compilation of suitable resource material by the teacher. Therefore, according to Hart and Robottom (1990), the primary factor is that "teachers must rethink their beliefs on what is worth knowing about science and must assume broader responsibility than simply passing along information" (p. 579). There is a need to develop alternative teaching strategies that facilitate participatory learning and independent inquiry of students. Learning refers to a process of constructing knowledge, in which students organize new information and experiences into their personal framework for understanding the world. They should be given opportunities to reflect upon their learning experiences. An integral part of this reflection process is sharing one's ideas and listening to the ideas of others (Hoebel & Mussio, 1991).

In addition, when wrestling with an issue, students have to apply their acquired knowledge. Therefore, it is possible to prepare students with problem-solving methodologies of and provide them with opportunities to practice these skills. The teacher can include a problem solving model to make teaching more effective. Pizzini et al. (1989) suggest a cyclical model, including four steps, namely, search, solve, create, and share (SSCS) that can be re-entered at any phase during the problem-solving process. According to Pizzini et al. (1989), SSCS can "easily be incorporated into science instruction, providing a successful and creative way for students to learn science and problem solving skills in science" (p. 527). SSCS is considered as an effective tool to develop students' higher order thinking skills. During the Search phase, students have to identify questions and problems, determine what information is needed to solve the problem and where to obtain it. With the assistance of the teacher, students can seek information from various resources, such as magazines, newspapers, materials, field trips, local community, etc., and then link these resources to their experiences and conceptual schemata. The Solve phase focuses on analysis and synthesis of the data based on which interpretations are generated. The Create phase emphasizes students' self-evaluation. Students should recheck their data and solutions, and then draw generalizations. The Share phase requires students to interact, share their own viewpoints, receive and process feedback, evaluate solutions and generate further research questions.

As a result, teaching strategies dealing with problem solving, lead to change in terms of teacher and student roles. Rather than acting as a transmitter of information to his/her students, the teacher is now seen as facilitating the direct interaction of students with information, acting as a coach who helps students learn how to learn, and being responsible for creating meaningful learning environments for all students. Students no longer absorb knowledge from the teacher passively, but come to be active learners in search of relevant knowledge, its correct application, and its critical evaluation. Further, the teacher has responsibility for supporting and promoting collaboration among students. Students get involved in group work, creating empathy among peers. An establishment of a non judgmental environment in the classroom is required. Students are encouraged to generate their own views and feelings freely, without the judgment of the teacher, as well as appreciate the points of view held by others (DeBecker, 1987; Pizzini et al., 1989).

In general, the problem solving format can be considered as a framework to be incorporated in any teaching strategy that focuses on social issues. It is desirable that the teacher selects and utilizes a wide variety of instructional techniques and classroom practices that focus on motivating student learning (Beisenherz, 1982). Social issues can be presented via case studies, minilectures, newspaper articles or films, etc. During the process of investigating the issues, students can be engaged in a debate and discussion, simulations and role playing, case study learning, or lab investigations. Several analyses indicate the benefits of such activities. Student problem solving, thinking and communication skills are reported to be enhanced, and student attitudes towards science are improved (Frazer, 1986; Yoong, 1987; Henderson & Lally, 1988; Herreid, 1994).

The use of case studies has been demonstrated as an effective path to teaching science and its social implications (Coleman, 1989). Students are presented with real-life cases and have opportunities to explore the linkage of scientific concepts and principles with the problem. Further, the dilemmas of the case require students to make critical evaluations and decisions. Tackling the cases, students have opportunities to be engaged in discussion with peers, and teachers assisting in exploring diverse perspectives around the issue. In a similar way, debate engages students in ethical discussion of issues and the pros and cons of various perspectives.

Simulation has been evaluated as a powerful way to deal with science-related social issues (Henderson & Lally, 1988). Participants assume and defend the roles of different elements in society or of members of the community, and consider various points of view through multiple perspectives (scientific, technological, social, economical, cultural, etc.) to acquire an understanding of the complexity and difficulties of societal problems. Science, indeed, is seen as a social activity.

In the "Science in Society" project (1986) conducted by the Association for Science Education (ASE) in the United Kingdom, a series of decision making simulation exercises was investigated. Students enjoyed the simulations, wanted to find out information for themselves, and developed analytical decision making and communication skills (Lewis, 1987).

Laboratory investigation and projects may be used to solve problems that have personal and social relevance. Under the project method, the socially relevant problems are placed in a central core of the curriculum (DeBoer, 1991). The activities are based on group work, in which participants discuss and develop a work plan, select a problem, collect data, carry out experiments, critically analyze and evaluate data and different viewpoints (Krasilchik, 1987).

Brinckerhoff (1985) suggests that incorporating short provocative questions through vignettes raises open-ended social issues in conventional science courses and can motivate students in learning about science and social issues, and shape positive attitudes toward science. The vignettes can be used for class discussion periodically, alone or in combination with other instructional procedures.

Sharing ideas and beliefs is recognized as one of the fundamental components of the instructional strategies presented and should be emphasized in the teaching of social issues. McInerney (1986) emphasizes:

> One of the most important outcomes of any discussion related to science and society is that students learn that such issues , even though they are not quantifiable, can be dealt with in a manner that is organized, rigorous, and intellectually sound. Failing to bring that organization and rigor to such deliberations often results in a series of unfocused assertions and opinions that bring more heat than light to the analysis. (p. 181)

Educators have made great efforts in disseminating the STS approach in general, and the issue approach in particular, in science education. Diverse curricula have been designed and implemented. The trials and field-tests have demonstrated satisfactory results that consolidate the STS perspectives. Some examples are illustrated below:

At the Federal University of Sao Carlos in Brazil, the ecology theme was the core of an introductory biology course. Students got involved in a research project concerning a real case study of a lake situated on campus, investigating the relationship between the lake and the surrounding terrestrial ecosystems. Learning activities included discussion, field and laboratory work. The approach appeared to motivate students in learning, improve their ability to analyze and synthesize data, and encourage them to use a more integrated approach to science (Unesco, 1977).

In the PLON Project (Physics Curriculum Development Project) - Netherlands, several units were written dealing with risk issues. One of the units, namely, Ionizing

Radiation, was structured with issues around the central theme - acceptability of the risks associated with applications of ionizing radiation (genetics effects, nuclear energy, radiotherapy, etc.). The field test of this unit on 25 classes in secondary school in 1984-1985 showed that the issues corresponded well with student interests. that students developed more positive attitudes towards radioactivity and rational judgments on risk issues (Eijkelhof, 1986).

Yager et al. (1992) found that teaching social issues in a Human Biology course for college students enhanced student understanding and use of science process skills, developed creativity and positive attitudes toward the biology course, science-related careers, and confidence to solve social problems with knowledge of biology.

James et al. (1974) developed and implemented a General Biology course at Parkway West Senior high school, in which sixteen social issues served as unifying themes related to ecology, cell biology, genetics and evolution. Students attended discussions, and undertook lab investigations and field work. The survey showed that 97% of the students were interested in learning social issues and most were motivated in learning science.

Evidently, student progress and achievement should be reflected in the overall evaluation. Assessment techniques should be developed in a way to measure all the objectives stated. With regard to the traditional discipline-based curriculum, assessment of student achievement mainly concentrates on the acquisition of factual knowledge. Achievement tests are not well matched to the task of evaluating students participating the issue-based activities (Aikenhead, 1990).

Yager and McCormack (1989) suggest that science teaching and assessment should encompass the five interrelated domains, including:

- Knowing and understanding (information domain),
- Exploring and discovering (process of science domain),
- Imagining and creating (creativity domain),

- Feeling and valuing (attitudinal domain),
- Using and applying (applications and connections domain).

The STS approach addresses applications and connections as starting points from which students study real-world problems. During the process of problem investigation, students are expected to develop positive attitudes and creative problem solving skills based on science information and processes. All five domains should be dealt with in the evaluation of a science program.

The issue-based approach emphasizes student exploration of issues. As a result, the skills of issue identification, information gathering, analysis and evaluation should be reflected in the overall assessment. Perkins and Blythe (1994) advocate "ongoing assessment" in which "students need criteria, feedback and opportunities for reflection from the beginning of and throughout any sequence of instruction" (p. 7). Feedback may come from the teacher, from peers, and from students' self-evaluation. Oral and written reports, lab assignments, and the other objective and subjective measures can contribute to the overall assessment. Classroom observation and student interviews are used to get evidence about student attitude change or cognitive level change. Generally, assessment instruments should enhance the measurement of student progress towards the development of creativity, problem-solving skills and an understanding of the interaction of science, technology and society.

In summary, with the tendency of science education innovation to match the changing industrialized society, the "issues" approach has demonstrated its potential benefits. In school settings, students have opportunities to cope with social issues in a personal and social context, through which they gain an in-depth understanding of science and scientific processes, of the interrelations of science, technology and society, and more crucially, they experience the problem-solving and decision-making strategies needed for future careers and for life. Further, students have opportunities to communicate with others, thus, learning to appreciate human values and perspectives. Science, indeed, should be approached in both scientific and humanistic aspects.

Chapter 3
Research Method

The organization of the study mainly encompassed the development of a set of instructional activities illustrating the issue approach in a cell genetics course and an investigation of how students responded to the approach when they got involved in such activities in a classroom setting. The setting was a third-year biology classroom in Department of Biology at Dalat University in Vietnam.

This chapter addresses the following sections:

- Description of the setting, and context of the study. The structure of the cell genetics course and current teaching strategies for the course at Dalat University are briefly examined.
- Overview of the instructional design and development which focused on the study of issues;
- Instructional sequence;
- Instruments and procedures;
- Data analysis procedure.

Description of the Setting

Context of the study

The study was conducted with a third year class in the Department of Biology, at Dalat University in Vietnam.

Dalat University is located in Dalat City in Lam Dong Province. It is one of the comprehensive universities in Vietnam which offer Basic Sciences and Social Studies as undergraduate programs, providing human resources for the middle provinces and remote highlands. Dalat University has adopted the credit system since 1994, and in 1995-1996, the total enrollment was about 8500.

The four-year undergraduate programs consist of two stages: (i) stage 1: students choose from one of seven general programs, and within this program, they take basic courses and some electives. Students obtain a general degree after taking three to four main semesters and satisfactory completion of at least 90 credits; (ii) stage 2: students have to pass a transfer examination before entering the second stage; the upper level consists of five main semesters requiring at least 120 credits from specified courses focusing on a particular area. There are two main semesters in an academic year: semester I (September -January), II (February -June) and an additional semester III (July -August). The seven general programs include: (i) program I, II, III offered for students whose interest are science, technology, agriculture-forestry-aquaculture or medicine. Core of program I focuses mathematics and physics, II on chemistry and III on biology; (ii) program IV for students who would like to pursue economics and business administration; (iii) program V for social studies; (iv) VI for humanities; and (v) VII for foreign languages.

Biology students can pursue a basic program for their first stage of a Higher General Education Program (Chuong trinh Dai hoc Dai cuong), and then pass a transfer examination to shift to the second stage for two years, taking specialized courses, depending on their interests and future career. In addition to the requisites of basic courses, students are to take at least 25 credits related to social studies and humanities in the first stage. This reveals a novel change in the curriculum of the institution.

Thirty nine third-year biology students who served as participants in this study just passed the examination that focused on testing the acquisition of basic knowledge in general biology and foreign language, and enrolled in the first semester of the second stage to take a core of advanced courses. All of them were from the same class during the first stage. When entering the second semester, they would have option of pursuing one within the three following particular areas with specified courses: (i) Resources - Environment; (ii)

Experimental Biology and Biotechnology, and (iii) Biology Education. The last semester would be spent doing a thesis or preparing for a graduate examination. It was recognized that the sample was the last population who entered the "academic year system" in 1993. So, to a certain extent, the program they pursued was a mixture of former and current curricula. Students had to study 10 required courses consisting of 450 class hours (equal to 30 credits - 1 credit was equal to 15 lecture hours or 30 lab hours) in 15 weeks. However, due to the timetable adjustment every week, they spent 35-40 hours in class per week at the beginning of the semester. Aside from the main program, the majority of students took additional courses (computing studies, English, etc.) related to their own needs and interests. Living far from families, about 1/4 of the class had to take part-time jobs to support their studies. The class consisted of 39 students, with 21 males and 18 females aged 20 to 25. They came from various cities of the middle provinces to remote highlands, about 1/5 of them from Lam Dong Province. Results from the transfer exam showed that about 2/3 of the class achieved good performance and 1/3 satisfactory performance.

During this study, not all participants attended the entire session concerning the study of issues; some missed one or another class period.

Structure of cell genetics course and current teaching strategies for the course at Dalat University

Cell genetics was an advanced and required course of the undergraduate program. It consisted of 3 credits for lectures. No labs were provided. The course expanded knowledge that students acquired in General Biology, especially in cell biology and genetics during the first stage. The framework of the course was approved by the Ministry of Education and Training, based on which teachers could organize the topics in detail and develop teaching strategies appropriate to their own context. The course covered eight units as follows:

Unit I : Introduction. Organelles of the cell and their genetic characteristics.

Unit II : Cell cycle and Mitosis.

Unit III : Meiosis.

Unit IV : The structure and function of chromosome.

Unit V : Changes in structure of chromosomes.

Unit VI : Changes in number of chromosomes.

Unit VII : Cytoplasmic inheritance.

Unit VIII : Evolution of genetic apparatus.

In Unit I, students were presented with the scope of the study, historical background, current advances and perspectives in cell genetics studies. Students had opportunities to reexamine the structure and function of the cell, primarily emphasizing the nucleus and its chromosomes, and then, chloroplast, mitochondria as basic components related to reproduction and inheritance. In Unit II and III, cell division, the basis of genetic continuity and transmission was investigated in depth. Mechanisms of mitosis and meiosis were examined in relation to inheritance patterns. In Unit IV, chromosomes and their behaviors in cell division and reproduction were described at the cytological level and somewhat the molecular level. Unit V and VI addressed cytological analysis techniques to explore chromosomal aberrations in terms of structure and number followed by an investigation of the nature and consequences of such changes in organisms (plants, animals, human). Unit VII explored the mechanism of cytoplasmic inheritance in relation to the structure and function of chloroplast, mitochondria and some cellular factors, and its applications to agriculture. In Unit VIII, the evolution of the karyotype from prokaryote to eukaryote as well as the karyotype changes within species and genera were examined, giving a better understanding of the evolutionary relationships of taxonomy groups.

The objectives of the course were to provide opportunities for students to:

- understand basic concepts and principles of cell genetics science,
- develop the abilities to think critically and solve problems scientifically ,

- develop positive attitudes towards science,
- understand the application of genetics.

In general, the course was to offer students a foundation for further academic studies and their future career. Students enrolled the course, attended lectures given by the teacher and took notes. The schedule was two to three 180-minute periods per week. Self-studying processes were mainly based on learning notes taken in class and textbooks. Reading supplementary materials was not required but left to the student choice and interest. There was, however, a shortage of textbooks, and most of them were out-dated. The main textbook was written in 1981 by a former professor from the department. References in the university library included some genetics textbooks published in 1979 and 1980. Five to seven specialized books published in 1984 and 1985 were offered as further readings. Vietnamese journals and magazines contributed to common knowledge rather than advanced knowledge. Further, students rarely engaged in group work or cooperative learning activities. Students would be assigned to prepare a few hours of seminars during the course (normally one 3-hour period) The instruction was mainly direct teaching in which the teacher played the role of knowledge transmitter. Contents of the lectures focused on the basic concepts and principles of biological science, with slight mention of the STS theme, or science-related social issues. The issues, indeed, were occasionally addressed as supplementary facts without providing opportunities for students to practice problem-solving and decision-making skills. The assessment system heavily focused on final exam tests that concentrated on the acquisition of basic knowledge.

Overview of the Instructional Design

The current science teaching as described above, in terms of curriculum and teaching strategies could not totally reach the intended objectives. One suggested approach was to integrate social issues into the course as a part of the curriculum core. The study then attempted to develop and implement the appropriate instructional and learning activities using the issue-based approach, as an integral part of the current course. Based on the literature review, it was intended to serve 15-20 hours in the total of 45 hours in the course for teaching and learning social issues. Issues would be selected on the condition that they were related to the content of the current curriculum. Basic knowledge was provided in advance as a conceptual framework for students to investigate the issues. Students were expected to apply scientific concepts and principles to health, social and environmental concerns. In other words, students would get some experiences of how to approach the issues from a scientific point of view, besides the other considerations (e.g. emotional, social, cultural, economic, and other dimensions).

The cell genetics course served as basis for further specialized courses, Plant Genetics and Selection, and Animal Genetics and Selection. Therefore, a suitable context for students might be giving them opportunities to explore the issues related to a human health theme, human diseases and genetics.

In the context of a cell genetics syllabus, an instructional design which focused on the study of issues related to human diseases and genetics was developed by the researcher. The theoretical basis for the design and its component will be described in detail in the next chapter. The second step was to implement the instructional design in a classroom setting, a third year biology class at Dalat University.

Instructional Sequence

The model was implemented in a third-year class in the Department of Biology at Dalat University during September and October 1995. Lectures and the study of issues were taught alternately during the course in which the issue activities were designed to supplement and support the lecture format. Lectures were given by the main instructor while issue activities were conducted by the investigator.

The instructional sequence for the issue activities were as follows:

Day 1 (in week 1): 30 minutes_

1. Address the course to students, in terms of content, teaching and learning strategies, evaluation criteria, and student tasks.

Prior to course learning, students were informed about the purpose of the study. An introduction letter, with an attached syllabus was distributed, addressing the objectives, schedule, learning activities and teacher expectations toward students (Appendix B). They were invited to sign a consent form if they would like to participate in the study (Appendix C). The construction of the overall framework of the course as well as assessment criteria for the whole course were the result of a discussion between the main instructor and the investigator. Also, the criteria for assessing the overall learning activities involved in the issue study were addressed to students and then modified based on their comments, before monitoring their activities.

Class discussion and participation was considered as a main activity during classroom periods and this was new to students. Therefore, some guidance for discussion was given to students in the form of a hand-out and teacher explanation (Appendix E).

2. Assignment materials (hand-out, article, study questions) related to Topic 1 (Cancer) to students to read and prepare individually for next class activities.

(After this initial orientation, students had a lecture class with the main instructor).

Day 2 (in week 1): 180 minutes

1. I had students reflect on their feelings and difficulties in preparing the topic.

2. I reminded them about rules and tasks when attending class activities.

3. I divided the class into groups of five to eight.

The whole class was divided into five groups with 5 to 8 students per group, identified as group I, II, III, IV and V. Students joined the group by choice with some influence from teacher suggestions in order to keep group heterogeneous in terms of gender and learning performance. Particularly, group V was formed based on the consensus of students who volunteered to attend a group interview. From the list of volunteers, I selected six students to form the group V which would be considered as a main source data for the study. Students worked in their same group during all sessions of the issue study. In day 2, only 27 students in the total of 39 attended class due to several students' late return after summer holidays of several students, and the distribution of group members was as follows:

Group I : 5 (3 females and 2 males)

Group II : 6 (3 females and 3 males)

Group III : 5 (3 females and 2 males)

Group IV : 5 (2 females and 3 males)

Group V : 6 (3 females and 3 males)

4. I had the students discuss the study question 1 (on cancer) as a whole class (20 minutes).

5. I had students discuss the study question 2 (on cancer) in small groups and prepare posters (50 minutes).

6. I had each group present their poster and talk to the class, followed by class discussion (50 minutes).

For group discussion, each group sat at a table and students sat face-to-face, while for class discussion, they sat in row, facing the blackboard.

7. I distributed materials related to Topic 2 (Human Genome Project) and assigned students to prepare in groups for the next class.

8. I had students give feedback and assigned them a short write-up as homework.

<u>Day 3</u> (in week 4): 180 minutes

1. I had the whole class brainstorm the study question 1(topic 2) to form a web map (30 minutes).

2. For the second problem, I had students identify diverse positions concerning the issue of genetic testing. Five positions were identified.

3. Role playing: I had each group select one position from which to investigate the issue. In day 3, more students attended class and were arranged into initial groups. In particular, group V kept unchanged (six members). The class comprised 34 students with 6 in group I, 7 in group II, 8 in group III and 7 in group IV.

4. I had groups discuss the issue and clarify their own points of view (50 minutes).

5. Groups presented their points of view based on group consensus about the issue; then, the class argued and evaluated different points of view generated by each group (50 minutes).

6. I distributed materials related to Topic 3 (Down's syndrome) and assigned students to prepare in groups for next class.

7. I had students give feedback and assigned them a short write-up as homework.

Day 4 (in week 4): 180 minutes

1. I reviewed the concept of genetic testing.

2. Students discussed and suggested one to three principles of genetic testing in small groups (20 minutes).

3. I had groups present their suggested principles and review a consensus list of principles on genetic testing (20 minutes).

4. I had students express their feelings toward Down's children they have met.

5. I introduced some features of Down's syndrome in Vietnam, and schooling and curriculum provided for Down's children (10 minutes).

6. Students discussed scientific knowledge concerning Down's syndrome (mechanism causing the disease, explaining graph in hand-out) (30 minutes).

7. I assigned a case study concerning the issue of abortion to groups for discussion (40 minutes).

Prior to group discussion, I had the students vote on the pros and cons of abortion.

8. The class argued and defended their points of view regarding to the pros and cons of abortion (40 minutes).

9. I distributed the hand-out for Topic 4 (Ionizing radiation and genetic damage) to students.

Day 5 (in week 4): 180 minutes

1. I invited a guest speaker to talk about ionizing radiation and genetic damage (140 minutes).

The speaker raised some questions related to basic knowledge in cell genetics, then introduced the analysis techniques on human lymphocyte karyotype, and his experimental research concerning the relationship between the frequency of chromosomal aberrations and dosage, dosage rate, and the nature of ionized radiation.

2. Students questioned the speaker (30 minutes).

The speaker was a researcher who had been working at the Nuclear Research Institute in Dalat, and pursuing his above mentioned project for six years.

Day 6 (in week 4): 120 minutes

1. I reviewed the four topics and their connections. I had students express their perceptions on the issues (20 minutes).

2. I had students write a final essay in class in 60 minutes.

3. I elicited students feedback with a questionnaire.

4. Refreshment and chat.

Instruments and Procedures

Demographic data

At the beginning of the course, students were asked to sign a consent form in which they could choose which activities to attend and to fill out a demographic form, illustrating students background, age, interest, plan in the future (Appendix C). Documents related to academic achievement in the first stage and transfer exam achievement of students were also considered, being used as one of the factors for group formation.

Students' attitude scale

When I found that students had studied genetics as basis to pursue the cell genetics course, I decided to explore students' existing feelings and ideas toward genetics and its values as well as specific issues concerning to genetics. It was believed that the initial attitudes of students could somewhat affect their learning as well as help the investigator follow their progress in learning science. Therefore, at the beginning of the course, students were asked to reply an attitude scale (Appendix D). It consisted of 18 items that covered three scales - enjoyment of cell genetics (5 items), values of genetics for student life and society (9 items), and views on specific issues (4 items). The scale was developed based on the framework of AISI (Gogolin and Swartz, 1992), and the structure of affective instruments being used for BC science assessment in 1991 (Batteson et al., 1992). Specific issues items were chosen with the intention that they would be addressed to students in a set of learning activities. The scale was checked by two colleagues in terms of its clarity and its significance to students before distributing to participants. Upon completion of the scale, the participants were asked to give comments on the scale.

The instrument used a Likert-scale. Students were asked to indicate their agreement with each item on a five-point scale; strongly disagree (SD), disagree (D), undecided (U), agree (A), strongly agree (SA). Each dimension included both positive and negative items. Regarding the positive statements, "strongly agree" was scored as a 5, and "strongly disagree" was scored as a 1. The scoring was reversed with the statements reflecting negative attitude. The number of responses that agreed with each item was determined by counting together the "strongly agree" and "agree" categories. The number of responses that disagree with each item was determined by counting together the "strongly disagree" and "disagree" categories. It was found that results of students' responses on negative items were compatible with those on positive items in the same scale.

Classroom observation

Observation was an advantageous instrument to unravel what was happening in a setting. Classroom observation was conducted during every class by the investigator /teacher with the assistance of one colleague each time. The investigator played the role of an observer participant, while the colleague was participant observer. The purpose of the observation was to obtain information on how students responded to the issue study and got involved in learning activities, and how the teacher facilitated their learning. A guide list and routine for observation and feedback was constructed, based on which a discussion with the outside observer was carried out to try to reach consensus on what would be observed prior to class activities (Appendix F). The participant observers attended class, took field notes based on the observation guide list, and exchanged opinions with me (the investigator) during the session. I also took part in class as an observer participant while guiding the sessions, and noted my observations in a diary after class. A follow-up interview with the outside observers provided me more feedback on the sessions. Consistent data were drawn from the sources, including field notes, small talk and interviews with the observers, and my diary. Overall, three observations with three different colleague observers were conducted, each lasting 180 minutes (on days 2, 3 and 4). In addition, I attended the seminar session (day 5, 180 minutes), and a lecture given by the main instructor (120 minutes) as a participant observer prior to the lesson on Down's syndrome. It was believed that data obtained could help illuminate more students' responses to the issue approach.

Interviews with the observers

One day after of the observation, an interview with the observer was conducted to obtain his/her feelings, comments and feedback on what happened in the setting and also to explore his/her own views on science teaching. It was believed that teachers' perspectives toward science teaching might have some impact on students' perceptions to the study of science involving the study of socioscientific issues. Overall, two interviews were conducted: one with the main instructor , and one with the other colleague, each lasting 45 minutes. Both were semi-structured interviews, based on a list of guide questions constructed by the investigator (Appendix G).

The following chart gives some description of informants:

Informants	Gender	Teaching experience	Working experience	Major
Observer 1 # Interviewee 1 (main instructor)	male	10 years	--	plant genetics
Observer 2 # Interviewee 2	female	20 years	8 years working at Institute of Medicine in Hanoi	microbiology immunology
Observer 3	female	12 years	--	animal physiology

The interviews were tape-recorded and then transcribed for analysis.

Feedback questionnaire from students

The implementation of the instructional design was completed, followed by a survey on students' opinions and feelings toward the issue study. A questionnaire was generated with nine items, in which four were closed questions and five were open-ended. In the questionnaire, students were asked to rate their level of interest in diverse learning activities and topics to be studied. In addition, they were invited to describe their outcomes and offer comments about learning activities as well about the investigator herself (Appendix H).

Group interviews

Group interviews are estimated to be effective instruments to reveal diversity in views and opinions among participants who are interviewed simultaneously. The relationships between respondent and interviewer and among group members can enhance group dynamics while stimulating the elaboration opinion. Used along with other instruments (for example, observation, individual interview, etc.), group interviews can triangulate data (Frey & Fontana, 1991; Holstein & Gubrium, 1995). However, it is recognized that group size, group members' views and their background can influence group responses. Typically, group size is limited to five to ten persons.

To acquire an insight into students' responses toward teaching and learning through social issues, a group interview was conducted with the chosen group (group V) three days after the issue sessions. Five of the six students attended the group interview.

A description of the interviewees from group V follows:

Interviewee	Age	Gender	Performance
Student 1	25	male	good
Student 2	23	male	satisfactory
Student 3	21	male	satisfactory
Student 4	20	female	good
Student 5	21	female	satisfactory

The group interview lasted 120 minutes. It was semi-structured, with major questions based on the purpose of the study and on students' responses to the feedback questionnaire. The focus of the interview was to explore students' interests and concerns and how they responded to the study of issues (see Appendix I).

During the interview, the question phrasing and pacing was adjusted according to the responses of individual students. To avoid the dominance of some participants during the group interview and to make sure that all of them were involved in the interview, each respondent was invited to express his/her opinions in turn.

Other sources of data

In order to explore how students learn and perceive the issue and scientific knowledge related to the issue, other sources of data were gathered, including tape-recording of group discussions, video-tapes of class activities, student write-ups and final essays.

For group discussion, tape-recording was focused on the chosen group (group V) and performed during the entire session. With assistance of a colleague, class activities concerning Topic 3 (Down's syndrome) was video-taped. It was a helpful source in gaining an understanding of how students behaved in their group and in class, and how they investigated the issue.

As a complementary source, student' write-ups and final essays were collected to analyze how students perceived and judged the issues. Overall, students were assigned to write two pieces as homework, concerning the two first topics. For the two last topics, because of a shortage time and busy student schedules, write-ups were canceled. The final essay was written in class in one hour upon completion of the session.

In general, a variety of instruments was used to gather a variety of data sources as triangulation to enhance the validity and credibility of the findings.

Data Analysis Procedure

Results of the attitude scale and close questions in the feedback questionnaire were determined by counting the number of responses for each category of each item. A comparison of the results of students' attitudes toward specific issues prior to the study (attitude scale) and upon completion of it was shown in terms of the percentage of responses falling into each category of the four statements.

Interviews and group discussions were transcribed and coded. The investigator transcribed such data in Vietnamese and rechecked the transcriptions. Coding of the data was repeated two times by the investigator. Initially, she read the transcriptions and classified in general themes and then, in subcategories. A week later, she reread the transcriptions, checked the former codes and modified some subcategories. Appropriate quotations in each theme were chosen and translated into English. Open-ended questions of the feedback questionnaire, essays and fieldnotes of the observations were coded and classified in the same frame. The themes were defined based on the second research question, including issue analysis, the learning of scientific knowledge and attitude toward science of students. Categories were developed and organized in each theme during coding of each source. Results were presented in terms of selecting pertinent data from the above sources which belonged to each theme. In addition, some new themes emerged during the coding process, for example, other students' outcomes from the study of issues and teachers' views on science teaching. As a result, some new codes were generated. Analysis and interpretation of the data obtained were mainly descriptive in nature.

The study was conducted in a local context and limited to the small sample of a single classroom. The qualitative approach applied to the study allowed the investigator to obtain an insight and interpretation of how students get involved in the study of issues. Results from the study may provide some foundations for further research. Indeed, it was an exploratory study of science curriculum development that focused on integrating social issues into the curriculum. The study may offer directions and considerations about how to help students learn science in a personal and social context, and then encourage the teachers to explore more about the benefits of the "issues" approach in their classrooms.

Chapter 4

Instructional Design and Development

The instructional design focusing on the study of social issues concerning human diseases and genetics, was developed based on the logical-rational approach from Tyler, Taba and Mager (McClaren, 1994). Some modifications were made with reference to a framework for unit design recommended by Hassard (1992).

The four components of the instructional design were as follows:

- Rationale to be developed considering student needs and social needs in a real context , and current research in science education.
- Objectives, concerning cognitive and affective domains.
- Activity-based design, identifying issues related to the theme of human diseases and genetics, including intended learning outcomes, content background, and learning activities with procedure to be employed for each topic.
- Assessment plan, describing measures to provide feedback with regard to student learning and the effectiveness of the instructional model.

Rationale

The study of biology in general and genetics in particular is relevant to every citizen in today's society. As a scientific discipline, it provides learners with an understanding of basic knowledge of a scientific domain and the development of critical thinking and problem solving skills. As a human endeavor, genetics is embedded in a social context and has a potential impact on human life. With regard to human health, advances in genetics and biotechnology make it possible to fight human diseases and improve the quality of life, but at the same time, raise diverse personal, ethical and social issues, such as the genetic testing of inherited diseases and abortion. The issues which reflect real life problems and have no clear right or wrong answers provide students with opportunities to practice decision making, based on appreciating relevant information and logical reasoning. Therefore, it is necessary to engage students in investigating the issues that should serve as relevant components of the curriculum. Such issues can be used to empower the intellectual and emotional development of students. Students could explore various perspectives of an issue, clarify their own views and understand that the scientific background of biology and genetics offers another basis for consideration in developing their viewpoints and beliefs.

Objectives

The objectives of the issue study are:

- to increase students' understanding of basic concepts and principles in cell genetics;
- to develop students' ability to respond critically to the issue.

Students should be able to:

- identify the issue;
- explore different points of view on the issue;
- clarify their own points of view;
- support their position by scientific evidence and by logical reasoning.
- understand the complex relationship between scientific knowledge and the decision-making processes;
- evaluate arguments.

- to develop positive attitudes in students toward science and the exploration of issues.

Students would be expected to:

- increase their interest in science;
- show their responsibility toward the issues under study;
- judge their own beliefs and values;
- enjoy working in group and share ideas.

Activity-based Design

The instructional plan offered a set of learning activities focusing on the issues of human diseases and genetics, applying a problem-based design. The design was to involve students actively in their own learning with the assistance of the teacher.

The selection of issues concerning human diseases and genetics was to match the following criteria:

- Relation to the content of the course
- Increasing students' understanding of basic knowledge
- Social relevance, involving personal, local, environmental and global concerns
- Existence of controversial problems
- Availability of appropriate resources
- Time limitation for the overall issue study was 15 - 20 hours

Upon consideration, the issues were chosen and introduced in terms of four following topics:

- Cancer: from prevention to treatment
- The Human Genome Project: genetic testing and its controversy
- Down's syndrome: prenatal diagnosis and abortion
- Radiation and genetic damage: safety and risks

Each topic was developed, providing a set of suggested learning activities in correspondence with the intended learning outcomes. An overview of the curriculum is illustrated in Table 1.

The following section describes in detail the activities for each session in detail, refers to the activity overview, learning outcomes, content background, materials, and learning activities.

Table 1. Instructional plan for the study of issues

CELL GENETICS	SUGGESTED TOPICS RELATED TO THE ISSUE	SUGGESTED LEARNING ACTIVITIES	OBJECTIVES Students are to:
Unit I. Cellular organelles	—		
Unit II. Cell cycle and mitosis	Cancer: from prevention to treatment	Read an article which examines a physician's opinions on cancer treatment, and the relationship of the physician with patients. Collect data concerning cancer facts in Vietnam and in the local community. Discuss the issue of cancer treatment and prevention. Discuss the relationship between lifestyle and cancer. Relate to the problem of smoking and nutrition. Write a short piece on euthanasia	Explore the many perspectives on the issue of cancer treatment and cancer prevention; Clarify own views and show awareness of cancer prevention; Clarify their own beliefs on euthanasia
Unit III. Meiosis	—		

Unit IV. Structure and function of chromosomes	The Human Genome Project: genetic testing and its controversy	Read an article which explores the opinions of Watson (Director of HGP).	Describe the research trends of HGP;
		Introduce the concept of bioethics	Interpret the significance and risks of HGP to human concerns;
		Brainstorm to explore follow-up studies of HGP	Define the issue of genetic testing;
		Role-playing: support diverse positions toward genetic testing (insurance company, government, future parents, etc.)	Explore and judge the many perspectives on genetic testing;
		Discussion to formulate several principles for genetic testing	
Unit V. Changes in number of chromosomes	Down's syndrome: prenatal diagnosis and abortion	Collect facts related to distribution of Down's syndrome in local community and lifestyle of Down's children	Be aware of Down's children as a social problem;
		Share ideas on the problem of dealing with Down's children in Vietnam and in local community	Define the issue of abortion, in relation to prenatal diagnosis of Down's syndrome;
		Read article to gather facts concerning the issue of prenatal diagnosis and abortion	Consider the pros and cons of abortion in the case of Down's syndrome;
		Case study for debating: - Students argue and defend their own points of view toward abortion - Students vote about the pros and cons of abortion in this case	Clarify their own points of view on abortion; Realize that practical decision making also involves values;
		Discuss the issue of abortion with reference to other genetic disorders	

Unit VI. Changes in structure of chromosomes	Ionizing radiation and genetic damage - safety and risks	Seminar given by a guest speaker. Topic: Techniques to analyze the karyotype of human lymphocytes - an exploration on the relationship between the frequency of chromosome aberrations and dose, dose rate, and the nature of ionizing radiation. Dialogue with the speaker	Understand that the frequency of chromosome aberrations is a measure to estimate radiation risks; Evaluate the significance of a scientific research to everyday life and society; Consider radiation risks toward the general population and individuals working with exposure to radiation
Unit VII. Cytoplasmic inheritance	—		
Unit VIII. Evolution of genetic apparatus	—		

TOPIC ONE: CANCER: FROM PREVENTION TO TREATMENT

Activity overview

Students investigate the issue, concerning prevention versus treatment of cancer through several activities: reading materials, seeking information, participating in discussion in small groups and in class, and writing a short assignment as homework.

Learning outcomes

After studying the topic, students should be able to:

- describe the nature of cancerous cells compared to normal cells;
- interpret some cellular and molecular mechanisms related to carcinogenesis;
- discuss possible causes of several types of cancer: lung, breast, liver, digestive tract, skin cancer;
- suggest scientific methods to verify a substance to be considered as a carcinogen;
- analyze the advantages and disadvantages of current cancer treatments;
- consider the need for cancer treatment and cancer prevention;
- discuss the relationship between lifestyle and carcinogenesis, and analyze the implications for cancer prevention;
- discuss whether cancer prevention is an individual or social matter, and cite evidence to support arguments;
- clarify personal views and possible actions to prevent cancer, e.g. lung cancer, breast cancer;
- determine the relationship between cancer prevention and treatment;
- analyze the approach of euthanasia and articulate their own beliefs on for and against euthanasia (optional learning outcome).

Content background

Cancer is the uncontrolled growth of certain cells in the body, in relation to a disruption of the cell cycle and mitosis. Cancer is considered as a behavior-related disease of our time. Treating cancer and preventing it are still vital issues in Vietnam. Cancer is normally believed to be incurable, and in real life, the causes leading to a type of cancer are often unclear. Many Vietnamese people lack awareness about cancer treatment as well as cancer prevention and which of these should be emphasized. Incidentally, the present growth of anti-smoking movement in Vietnam can serve as a motivational factor to investigate the relationship between lifestyle and cancer, not only of the individual but also of the community. In addition, information about cancer prevention can be promoted and disseminated.

Students have acquired an understanding about cell cycle and mitosis as a basis to explore how a cancerous cell is generated, and what causes a normal cell to convert to a cancerous one. The genetic basis of cancer will also be examined, leading to a discussion of carcinogenesis and its relationship to the environment.

Students explore current methods in cancer treatment with its benefits and risks. From an understanding about the limitations of cancer treatment and the nature of carcinogenesis, students will be involved in discussion based upon whether cancer treatment or prevention should be emphasized. Perceptions on early diagnosis of cancer, attitudes and actions to be shaped for preventing cancer will be considered with actual evidence. In addition, the acceptability of euthanasia is another issue to be dealt with.

Time: one 180 minute period.

Materials: (Appendix J)

1. Handout and attached study questions.

2. Article: Phong van Giao su Leon Schwartzenberg (1991, thang 7). Nguoi dua tin Unesco, 4-9. [Interview with Professor Leon Schwartzenberg (1991, July). The Unesco Courier].

Procedure

1. Student preparation as homework

   - Read handout.
   - Read the article.
   - Prepare study questions.

2. Present a problem to be discussed (study questions 1 and 2).

   - Current situations regarding cancer development in Vietnam.
   - Priority of cancer prevention over cancer treatment or vice versa.

3. Small group discussion

   - Form groups of five to eight students.
   - Assign discussion and preparation of a poster to groups.

   Students are to:

   - explore current situations of cancer development in Vietnam;
   - discuss mechanisms related to carcinogenesis:
   - suggest scientific methods to identify a substance as a carcinogen;
   - discuss possible causes of several types of cancer;
   - give evidence for the interpretation (statistics, experiments, etc.);
   - discuss benefits and risks of current cancer treatment:
   - consider the issue of cancer treatment and prevention and give reason for the priority;

- discuss the relationship between lifestyle and cancer, between environment protection and cancer:
- clarify their own points of view and make an action plan.

4. Presentation in class and discussion.
5. Assignment

Students write a short assignment to:

- define the issue of euthanasia in cancer treatment and arguments for and against euthanasia;
- clarify their own judgment toward euthanasia;
- report what they have learned about cancer through class activities.

TOPIC TWO: THE HUMAN GENOME PROJECT: GENETIC TESTING AND ITS CONTROVERSY

Activity overview

Brainstorming was used to generate the subsequent researchable areas of the Human Genome Project (HGP). The issue of genetic testing, as a consequence of the HGP, creates much controversy. Students engage in role-play to investigate and evaluate the varying perspectives.

Learning outcomes

After studying the topic, students should be able to:

- describe a human karyotype with its characteristics;
- describe the molecular structure of human chromosome;
- explain the behavior of chromosomes in relation to cell division;
- explain how the human genetic map is structured, and cite scientific techniques to be used;
- analyze the advantages and disadvantages of scientific techniques to be applied to construct the human genetic map;
- summarize the principle research process of the HGP and its perspectives;
- analyze the significance and risk of the HGP;
- identify the issue of genetic testing;
- justify diverse points of view concerning genetic testing;

Content background

On the basis of understanding the structure and function of chromosomes, especially in humans, students have opportunities to study the Human Genome Project and its risks and benefits. Techniques to be used for constructing a human genetic map are examined. Research trends of the HGP are introduced.

Advances in the HGP leads to the issue of genetic testing which is a highly controversial public issue because of the diverse positions that people support. The pros and cons of genetic testing as a component of bioethics need to be discussed among students because they affect the life of individuals and families, and have broad social dimensions. Exploring the various perspectives and judging them is an integral part of this issue study.

Time: one 180 minute period.

Materials: (Appendix J)

1. Handout and attached study questions.
2. Article: Ibanes, S. G. (1993, Oct). Phong van Giao su James D. Watson. Nguoi dua tin Unesco, 4-7. [Interview with James D. Watson. The Unesco Courier].
3. Article: Kutukdjan, G. B. (1994, Sep). Unesco va dao duc sinh hoc. Nguoi dua tin Unesco, 23-25. [UNESCO and bioethics. The Unesco Courier].

Procedure

1. Student preparation as homework
    - Read handout
    - Read articles
    - Prepare study questions
2. Brainstorm in whole class and construct a web map about the subsequent researchable areas once the HGP has completed the human genetic map.
3. Present the issue of genetic testing and have students identify diverse positions.

4. Role playing:

- Each group supports one position to investigate the issue.
- Students discuss in small groups and clarify their own points of view.
- Obtain consensus in the group.
- Groups present points of view that support their position to the class.
- Have class argue and evaluate different points of view generated by groups.

5. Discussion

- Discuss in groups and suggest one to three principles on genetic testing.
- Groups present their suggested principles.
- Review a consensus list of principles on genetic testing.

6. Assignment: Students write a short report to clarify their own opinions on the topic after class activities and solve a genetics problem about Huntington's disease.

TOPIC THREE: DOWN'S SYNDROME: PRENATAL DIAGNOSIS AND ABORTION

Activity overview

Students are to explain factors and mechanisms causing Down's syndrome through reading materials and discussion. A case study, illustrating the issue of abortion and its complexity, is offered to spark debate in the entire class.

Learning outcomes

After studying the topic, students should be able to:

- explain the mechanism causing Down's syndrome;
- explain the relationship between maternal age and risks of Down's syndrome in infants;
- describe two fetal testing techniques with their advantages and risks;
- analyze a case study concerning the prenatal diagnosis of Down's syndrome and abortion;
- identify the issue of abortion;
- clarify diverse points of view around abortion, and support their own point of view;
- realize that practical decision making also involves personal values.

Content background

Down's syndrome is estimated as the most prevalent genetic disorder in society. In my local community (Dalat City), there is a school for retarded children. The total number of children attending the school is about 50 of which nearly 30 are Down's. It is not only a personal but a social problem.

Advances in prenatal diagnosis permit detection of genetic defects in unborn children, from which the issue of abortion is generated. Students are to apply knowledge about meiosis and chromosome aberrations to explain the mechanism causing Down's syndrome. They are given opportunities to be involved in a case study and to debate the pros and cons of abortion in this case. They are to consider scientific, social, cultural, economic factors and personal values in decision making.

Materials: (Appendix J)

1. Handout and a case study with attached study questions.

2. Article: Galjaard, H. (1994, Sep). Chan doan truoc khi sinh: ky su ve mot su song duoc bao truoc. Nguoi dua tin Unesco, 17-19. [Prenatal diagnosis: a chronicle of a predictable life. The Unesco Courier].

Time: one 180 minute period

Procedure

1. Student preparation as homework:

- Read handout
- Read articles
- Prepare study questions

2. Present some features about Down's syndrome in Vietnam, and Vietnamese schools and curriculum for students with Down's syndrome.

3. Whole class discussion:

- Relationship between maternal age and percentage of Down's infants.
- Give reason for the evidence above.

4. Present the case study to class

- Have students vote on the pros and cons of abortion
- Group discussion about the case study

5. Class discussion

Students argue and defend their own points of view toward abortion.

6. Extension activities:

- Have students investigate the distribution of people with Down's syndrome in local community (through news, items, talks with physicians or annual health report, etc.).

- Have students investigate lifestyle of people with Down's syndrome in terms of their syndrome and their relationships with others within and outside the family.
- Have students connect abortion to other genetic disorders and suggest criteria for making decisions.

TOPIC FOUR: IONIZING RADIATION AND GENETIC DAMAGE: SAFETY AND RISKS

Activity overview

Students attend a seminar given by a guest speaker and have a dialogue with the speaker after the seminar.

Learning outcomes

After studying the topic, students should be able to:

- explain the mechanism by which ionizing radiation causes chromosomal aberrations;
- identify and differentiate several types of chromosome aberrations on microscopic slides;
- read a scientific report critically;
- consider radiation risks toward the general population and radiation workers;
- evaluate the significance of scientific research to everyday life and society.

Content background

There is evidence of the relationship between ionizing radiation and genetic damage. The presence of a nuclear power plant in a local community can create various problems, for the safety for people working in the plant and for those living in residences nearby. The topic gives students opportunities to examine the risks and safety in dealing with ionizing radiation.

Students attend a seminar that investigates the relationship between the frequency of chromosomal aberrations (especially structural aberrations), and dose, dose rate, and the nature of ionizing radiation (beta-, gamma-, neutron rays). Techniques to analyze the karyotype of human lymphocytes are introduced as means to explore several types of abnormal chromosomes. Students get opportunities to be familiar with how to conduct scientific research from the guest's introduction concerning his experimental and empirical research. For example, the guest uses in-vitro culturing of human lymphocytes and treating them with different types of radiation, examining lymphocyte karyotype of a sample of residents living in Dalat. The students can then evaluate the significance of this research. It is expected that students will appreciate the need for accurately estimating radiation risks and planning radiation protection for the population and people who work with ionizing radiation.

Materials: (Appendix J)

1. Handout with outlines of the seminar.
2. Microscopic slides, transparencies of human lymphocyte karyotypes.
3. Scientific reports of the guest speaker.

Time: one 180 minute period

Procedure

1. Student preparation before class: Read outlines of the seminar, and gather some relevant information on ionizing radiation and genetic damage.
2. A guest speaker who specializes on genetics and nuclear radiation is invited to deliver a seminar entitled, "Techniques to analyze the karyotype of human lymphocytes - An exploration of the relationship between the frequency of chromosome aberrations and dose, dose rate and the nature of ionizing radiation".

Seminar process (two hours) conducted by the speaker, includes:

- introducing the topic;
- raising several questions to students to find out what they understand about mitosis and chromosome aberrations;
- introducing techniques of preparing blood slides and analyzing karyotypes;
- introducing experimental research to explore the relationship between the frequency of chromosome aberrations and dose, dose rate, and the nature of ionizing radiation.

- introducing empirical research to explore the distribution of the frequency of chromosome aberrations in a sample of residents living in Dalat (local community);
- clarifying the significance of the study;
- proposing subsequent researches;
- inviting students to share ideas and pose questions.

3. Students examine microscope slides and transparencies.

4. Short dialogue between guest speaker, teacher and students. Suggested aspects to be discussed are:

- what students are interested in the seminar and what further information they need;
- radiation protection policies in the Dalat nuclear power plant;
- careers related to the risk of exposure to ionizing radiation,
- environmental protection for surroundings of a nuclear power plant.

Assessment Plan

An assessment plan was designed to serve two broad purposes:

- to provide feedback with regard to student learning,
- to provide data with respect to the effectiveness of instructional plans.

The activity-based design focused on the process of investigating the issues by students. Therefore, the assessment measures involved both formal and informal methods. Formal methods related to the evaluation of students' writing. Informal methods included observation of small group and class discussions and presentations. The measures evaluated the achievement of learning outcomes and provided feedback on student learning. In addition, questionnaires and interviews with students gave feedback on how students responded to the instructional model.

Chapter 5
Findings

This chapter presents the analysis of data obtained from the field-test of the instructional design. The conceptual framework for findings was based on the second research question, i.e. how students responded to the issue approach. It consisted of three themes:

1. Issue analysis;
2. Learning basic knowledge in cell genetics through the study of issues;
3. Attitudes toward science and social issues.

The first theme was concerned with the extent to which students approached and explored the issues under study while getting involved in several intended learning activities. The social issues under investigation were science-based and controversial. Students were expected to gain an understanding of these issues while exploring differing points of views, including ethics, values, science and other aspects. Scientific knowledge was part of the language of socioscientific issues. It included facts, concepts, principles and theories which were constructed through the scientific process, forming the knowledge base of science. Students were to use scientific knowledge as one way of analyzing the issues. Furthermore, it was assumed that the study of issues would have certain effects on the way students acquired and reinforced scientific knowledge as well as their attitudes toward science and social issues. In other words, the second and third themes were considered to some extent as consequences of the first theme.

The three themes were documented primarily through a feedback questionnaire from students and a group interview with students, and secondarily through a final essay and written reports, observations, and recordings of group and class discussion. Students' responses in all sources were coded under a theme and organized into categories.

In the feedback questionnaire, students were asked to offer opinions and feelings about the study of issues after participating in the field test of the design. Students' responses were coded and counted in terms of number responding for a wide range of variables which were derived from the major themes. The variables falling into more than one theme were also recorded (see Appendix K). Similarly, students' responses in the final essay were coded in terms of the types of reasoning they used to support their own points of view (Appendix L).

Issue Analysis

Students' interests and concerns

Normally, students acquired scientific knowledge through the familiar medium of lectures given by the teacher. They indicated that they were not quite satisfied with lectures which mainly provided them with basic knowledge of science.

In the group interview, one student said that there were topics mentioned in lectures that were not covered in sufficient detail. He felt stimulated to seek more information on these topics from other materials or from friends. He expected to explore the application of science and technology to real life, and supplementary learning activities to some extent responded to his needs as a learner. This student wanted to apply basic knowledge he acquired to investigate issues with the teacher' s guidance. Another reported that lectures were interesting. However, she pointed out that having opportunities to study the issues beyond textbooks and lectures and discuss them with peers made learning more engaging. One student wanted to be an active learner. He recalled his experience:

> When I was a first year student, I suggested that my plant biology teacher give us a certain problem for investigation. I wanted to have the opportunity to seek information and organize my knowledge, and write an essay about such problem under the teacher's guidance. But sadly, none of my teachers have provided activities like that in any of my classes.

Generally, the idea of infusing social issues into a science course and providing opportunities for students to investigate issues seemed to match students' needs and concerns.

Identifying the issues and relevant information

The study of issues was incorporated into the syllabus of cell genetics. Knowledge base related to the issues was provided in advance in terms of lectures (given by the main instructor) and handouts and articles (distributed by the researcher). Students were asked to investigate particular issues identified by the teacher, in terms of study questions and a case study. The primary step was to gather relevant information from diverse resources. Students' responses from the feedback questionnaire showed that the main resources they used and found effective were textbooks, lectures, handouts and periodicals. Few students considered teachers, friends, television and experts as main resources in their study. This might result from students' traditional learning style in which they worked individually and sought information from materials rather than from sharing knowledge and opinions with others. Some students said that they felt fear of being wrong when asking the teacher while others thought that their peers had little information and no interest in arguing. Most students noted that they used two or more kinds of resources.

Specifically, it was observed that in the first session on cancer, students brought additional materials to class, including magazines, articles and books which were related to the issue of cancer prevention and treatment, and introduced them to one another, especially in their own groups. Some article titles were noted (for example, "Breast cancer", "Guidelines to early diagnosis of cancer", "Smoking and lung cancer"). The enthusiasm in showing new materials to each other demonstrated student motivation in learning. As students expressed in a group interview, it was the first lesson in which they were involved in unfamiliar learning activities, so they were curious and tried their best to prepare for the first session.

When asked the relationship between the study of issues and understanding of scientific knowledge, a student in a group interview said that an understanding of basic concepts and principles from lectures could help students analyze an issue scientifically. He added that further information is needed, for example, news and facts related to the issue, as evidence for the issue analysis.

During the process of gathering information concerning the issues, students could generate questions. Questions raised by the students themselves revealed dilemmas and discrepancies which could motivate them to explore the issues. One student offered an experience from his study:

> When exploring a problem or an issue, I often ask myself several questions which may seem foolish and funny to others. For example, with the Human Genome Project, I asked a question like this: Can we create a copy of a human being from his/her genome? It may not realistic but it motivates me to think about that and other questions. I found out that some questions are researchable and others are not but both stimulate my imagination. ... My questions are odd, I think, so I don't share these ideas with my friends, but think by myself about them.

Students tended to focus primarily on scientific knowledge when approaching an issue in which their experiences and facts served as a stimulus for the information process.

From a recording of a group discussion about the issue of cancer prevention and treatment, it was shown that students started discussion by identifying facts and experiences they felt confident of. For instance, they mentioned the rate of liver, lung, breast, and other cancers in the world, as reported at the BBC. One student addressed lung cancer in the context of his family. His grandfather had died from lung cancer, and the student had seen him suffer the different stages of the disease.

Through discussion, they explored what cancer was, the causes of cancer, the genetic basis of carcinogenesis and the mechanism of metastasis. In dealing with this issue, students had opportunities to organize scientific knowledge they acquired from lectures and handouts and expand their understandings toward the issue by collecting more information. They analyzed the principles of current cancer treatment methods reviewed in the article "Interview with Professor Leon Schwartzenberg". One student explained the concept of carcinogen to his classmates. They discussed different carcinogens like smoke, drugs and alcohol, and their effects on cell activities. One student suggested that in order to understand how a carcinogen could change a normal cell into a cancerous one, one must investigate how a normal cell works in terms of cellular metabolism, cell division and cell interactions. Various questions were posed by students themselves. Some were related to a comprehension category, such as, "Is cancer inherited?" or "Can protooncogene be deleted from the genome of an organism to restrict the growth of cancer?" Others required analysis and synthesis, such as, "Why are certain factors considered to be carcinogens?" or "What is the role of these factors in changing protooncogene into oncogene?" Students attempted to give answers to the questions, using knowledge they acquired. For the latter questions, they tried to identify possible solutions, including obtaining statistical data from empirical studies, analyzing the elements of a carcinogen and doing experiments on animals. To some extent, students had opportunities to practice an inquiry into science. They found out that additional information was needed. When considering the need for cancer treatment and cancer prevention, one student posed the following assumption: "Many types of cancer are still incurable. To create an effective treatment method requires a deep understanding of causes and mechanisms of cancer". Another student said, "In a similar way, to prevent cancer effectively, we must understand what the causes of cancer are". Students were engaged in exploring major concepts and principles of science in the context of an issue.

In dealing with the Human Genome Project (HGP), students obtained an overview of the project and showed their interest in various perspectives on the study. The issue of genetic testing, which emerged from achievements of the HGP, seemed ambiguous to them. Recordings of class discussions showed that students tried to understand the concept of genetic testing, identify different concerns for genetic testing (for example, economic, political and ethical dimensions), but appeared to fail to know how genetic testing could proceed. No facts or experiences contributed to their learning. Lectures on the structure and function of the chromosomes were not provided to students prior to participation in the issue study as scheduled. Generally, a lack of relevant information seemed to impede students' process of issue analysis.

In the third session, to facilitate students with the issue study of Down's syndrome and abortion, they were asked to express their feelings and experiences about Down's children. Some real life information about Down's children in the community was provided. Also, time was set aside for students to explore and discuss scientific knowledge about Down's syndrome, including the mechanism causing Down's syndrome, the relationship between maternal age and incidence of infants with Down's syndrome. It appeared that students were more motivated when taking part in discussion of the case study of Down's syndrome and abortion.

When considering the issue of abortion, students brought into play other kinds of scientific knowledge and their own experiences. In a group discussion, one student said that she knew a Down's child. From her words: " Although the child obviously has different physical features, he can express his love for his parents and know that his parents love him. I think family relationships can help the child develop, even though he has Down's syndrome". The class was challenged with the question of whether a four-month old fetus was considered to be a human being. Knowledge of developmental biology was dealt with in different dimensions. Some argued that at this stage, the fetus was a human because it had complete organs of a human, while others said that the brain and other organs were not functioning yet. Another suggested that they needed more information about the unborn child's risks of having other diseases associated with Down's syndrome prior to considering the issue.

The fourth session (Radiation), unfortunately, was carried out the day following the third session (Down's syndrome). Hence, students had no time to prepare the issue in advance in terms of gathering meaningful information. Moreover, when attending the seminar, students received an overload of information from the guest speaker, as a one-way communication. What students most remembered was a set of chromosomal anomalies categories that were observed from microscopic slides of human lymphocytes under radiation treatment.

Exploring different points of view and clarifying one's own points of view

Issue analysis was characterized by identifying potential alternatives for an issue with evidence to support each position. Throughout the process, exploring others' points of view and clarifying one's own view were essential, to a consideration of the most reasonable solution was proceeded. It seemed suitable to investigate controversial topics in a cooperative learning context. Students were encouraged to work together and entered discussion with peers to explore the many facets of an issue. In an interview with the chosen group, I asked how students tackled an issue. As one student perceived:

> A problem or an issue can be examined in differing aspects. Therefore, I often consider various aspects, review them, and draw my own conclusions. To me, listening to others' views helps me to form my own point of view. ... In life, some problems are difficult to understand. Such problems need to be talked about so that we can come to an understanding. For example, there are many perspectives on religion, and I don't know what my peers think about it. So I like to express and defend my own point of view as means to explore others' views, from which I can draw some conclusions.

To this student, a person's manner of expressing their views reflected their own beliefs and values. He noted: "Some express their views frankly, others don't go directly to the problem but circle around it". As for him, he preferred "going directly to the problem".

Otherwise, beyond knowledge, students' points of view also reflected their own beliefs and values and they tackled different dimensions of the issue, including scientific, social and moral concerns.

Another student described her way of responding to dilemmas in an issue:

> During the discussion of an issue, there exist many controversial opinions. I then ask by myself why they are so controversial and try to explain it, explore the basis and evidence for these views and share ideas in my group to clarify them.

Depending on students' learning styles and experiences, they emphasized different skills in solving problems. One student considered gathering information from various resources to be essential to his study. This included seeking information from written materials, and asking the teacher if the problem was too difficult. In real life, for him, the way to solve a problem depended on his ability and on the resources available for problem-solving. The student indicated that the great pressure for him in solving a problem involved a high expectation of himself. He said that for him, the purpose of learning was to become an educated person, not to pass an exam or obtain a good grade. Another student distinguished which problems could be solved and which could not. For a solvable problem, the crucial component for him was to analyze it to explore what he did understand and to find the extent of the problem, and what further information he needed. To him, creating relevant questions to start the process of issue analysis was valuable.

One challenge for students was to accept the idea that there was no right or wrong answer regarding an issue. There existed conflicts about decision making among students. One student required a right decision to be made on an issue:

> I think the idea that there is no right or wrong decision on an issue can lead us to misunderstanding it. How can you understand an issue if you present it one way and I another way, and then no decisions can be made? I think there should be a right decision.

The remaining interviewees advocated the idea of no right or wrong decisions. One student agreed that "it is possible to get no right or wrong answer for the issue under discussion". To him, "criticizing a decision as wrong will diminish class motivation". Otherwise, he emphasized that "the problem is not whether the decision is right or wrong, but how to make decisions and on what basis of understanding". In other words, he felt that the process of reasoning leading to decision making was more important. The others were unanimous that it was more reasonable to accept no right or wrong view on an issue because each person could support his/her own position and have differing views, often concerning moral and social aspects beyond science. However, they would like the teacher "to review and define to what extent the problem was solved and to identify which decision was best". One student insisted that "we students need the teacher to offer us a certain trend for the issues that seems most reasonable and relevant".

The following examples illustrated how students explored and analyzed varying points of view about a particular issue. An understanding of scientific knowledge in relation to a certain context could aid students' reasoning. One student declared in her written report after the class session:

> From an understanding of cancer, including what cancer is, causes of cancer and mechanism of metastasis, I realize the importance of cancer prevention.

Another student elaborated this view:

> In our country, a developing country, medical services and research aren't well developed. There is a shortage of equipment. So, I think, cancer prevention should be emphasized rather than cancer treatment in our situation. Moreover, factors, such as diet and lifestyle have been proved to be associated with cancer. I think that cancer prevention and early diagnosis are less complicated and less expensive than cancer treatment, although both are important. There are still patients with cancer who need to be treated and encouraged to live in a better life.

In group discussion, students spent more time discussing the relationships between lifestyle and environmental pollution with cancer. Students actively shared ideas. Some expressed their worries about air pollution from dusts and vehicle exhaust which are potentially harmful to human health in several Vietnamese cities. Also, it appeared that smoking was a relevant problem. Students drew evidence from articles they brought to class, showing the hazards of cigarette smoke with regard to lung cancer and other respiratory diseases. The danger of exposure to secondary cigarette smoke toward nonsmokers was discussed. Female students opposed male students' habit smoking since smoking wasted money, smelled bad, and could affect the health of the family, especially of children.

One student posed a question of how to identify the existence of a carcinogen in the environment. The group members felt challenged. One student offered an example of the workers in a nuclear power plant that there was equipment to measure and detect the dosage permitted of ionizing radiation in the environment as well as in the human body. It might be a question that merits further investigation because the group had not enough information.

In a final essay, students were asked to express their perceptions of four statements concerning the four issues under study. Student responses were coded into categories for each statement (see Appendix L)

There were responses which were quite simple, and focused narrowly on one dimension. For example, in the responses to the statement "Genetic counselors should make all decisions for couples with possible genetic problems in their unborn child", only the role of counselors was mentioned while the role of the couple was forgotten. There were students who agreed that genetic counselors should make decisions for couples. Their reason was that the counselors appreciated the severity of a genetic disease, how it affected the child and how it was inherited by the child's descendants.

There were responses trying to explore differing points of view on the issue. Some examples follow:

To respond to the statement concerning the role of counselors, several students linked it to a case of prenatal diagnosis of Down's syndrome. To make a decision to abort or keep the fetus until birth, they dealt with different considerations, including:

- The role of a genetic counselor to inform the couple of pertinent scientific information and assist them with their psychological concerns;
- The role of the couple to perceive their responsibility and feelings of affection toward their unborn child if they decided to continue with the pregnancy;

- Other associated factors, such as the pressure of family, society, and cultural, religious and ethical concerns.

Most students advocated that the couple should make decisions upon deliberate consideration of all such factors. One student wrote in his essay:

> Genetic counselors only help carriers assess the risks of genetic defects and provide them with relevant scientific information as a basis for them to make reasonable decisions.

Another student wrote:

> There were a lot of arguments about this issue in my class. In the case of for and against abortion, most fellow students advocate that the couple keep the unborn child. I agree with this, but parents of the child are the ones to make such decisions, not genetic counselors.

Regarding the first statement (on cancer) and the fourth statement (on radiation), students tended to apply scientific knowledge as the primary explanation for their agreement or disagreement on the issue. Some gave statistics and observations as evidence to reinforce their opinions. Students mentioned the effects of mutagens, including carcinogens, on the cell and on the expression of protooncogenes. The complexity of the consequences was addressed, for example, changes in protein synthesis, in the control mechanism of cell division, and in metabolism and the activities of the immune system in an organism. Several students insisted that exposure to mutagens was just one of the factors that could cause cancer. Other factors should be dealt with, including viruses, diet and lifestyle. Some evidence from society was cited, such as the high ratio of patients with a particular type of cancer found in regions contaminated by Agent Orange (Quang tri, Daklak), or by massive amounts of radioactive substances (Chernobyl).

It appeared that students easily agreed with the fourth statement. They explained that ionizing radiation could directly affect the chromosomes during cell division causing breakage of chromosomes, and could also have effects on the following generations. Such information might have been acquired from the seminar students attended. Slides showing different types of chromosome breakage in human lymphocytes captured students' attention. Some students analyzed diverse factors which could change the incidence of genetic damage to some extent, such as dose, dose rate, the nature of radiation and time of exposure to radiation.

Dealing with the issue of genetic testing, most students were unanimous that scientific advances should serve the improvement of human life and respect of human values. They felt that human rights and freedom should be regarded as priorities. As a result, students advocated that genetic testing should be voluntary but not mandatory. However, they also analyzed the interactions between individuals and families, as well as between the individual and society. One student wrote:

> The freedom of every individual should be respected. No one has the right to require others to declare their DNA. However, relatives or concerned agencies should encourage those who have risks of genetic disorders to have a genetic test, but should keep this information confidential.

To some extent, students realized that the issues were approached not only in scientific dimensions but closely to the human values. When asked to write about impressions of the study of issues in the final essay, one student wrote:

> I have had the opportunity to explore several genetic diseases in terms of cause, mechanisms and consequences of the diseases. Beyond scientific knowledge, I am starting to be interested in the personal and social concerns of the patient's life, and feel responsible for myself and my relatives if we contract a disease.

Another expressed similar feelings:

> The study of issues makes me feel that my life is valuable and I developed an empathy with people who have an incurable disease.

Learning activities compatible to the study of issues

Being engaged in the study of issues, students were encouraged to share their knowledge, experiences and beliefs, though, some had certain difficulties. A shift from a familiar learning style (listening and taking notes in lectures) to an unfamiliar one (exchanging ideas orally) could bring certain difficulties for some students. Depending on students' dispositions and experiences, diverse behaviors in communication were reflected.

Two female interviewees evaluated themselves to be quiet and used to listening rather than talking and they felt nervous when talking in front of the class. However, they felt easier about sharing ideas in their small group, which involved asking questions about things they did not understand and addressing what they knew. One of them recalled her feelings:

> The first session, I knew things and had opinions but didn't dare talk. In the subsequent sessions, I could talk more easily. I even was reluctant at first to ask friends about what I didn't understand.

Two male students felt confident while talking in a crowd. Explaining this, one student said that he had to earn his living early, while another said that he used to be called on in class during his high school years and noticed that sometimes he felt himself dominant in talking in his group. The remaining male student said that he was not nervous when talking but had a little trouble arranging ideas in his mind. He emphasized individual effort as an important component in making discussion beneficial:

> Discussion is useful but must be preceded by gathering information and sharing it in a group, in class, giving students opportunities to clarify and examine which information is relevant.

Responding in a similar way, in the feedback questionnaire, most students reported that they felt more comfortable in group discussion than in class discussion: 26 said they were very comfortable in group discussion, while only 15 were very comfortable in class discussion. However, several students commented there were times when the discussion was wandering.

To facilitate students' participation with the issue study, students were engaged in a set of learning activities. Students' responses from the feedback questionnaire reflected their general assessment of such activities. The acquisition of knowledge was typically estimated as the most important criterion of student performance by both teachers and students. In the present situation, due to a shortage of materials, attending lectures to obtain information from the teacher was the major learning activity of students. In students' view, lectures were considered to be effective to their study. Discussion in group and class, although not very familiar to students, was also to be effective to their study. Fewer students estimated the remaining activities, such as writing reports, reading written materials, giving class presentations and attending seminars to be effective.

Interactions during learning activities could provide diverse opportunities for students to learn, and to some extent, could shape students' behaviors and attitudes. One student wrote:

> I felt less interested in the issue of Human Genome Project (HGP) than in the issue of cancer because it is of less public concern than cancer. Moreover, I missed reading materials and handouts concerning HGP, and therefore, felt perplexed and did not understand what the teacher and my classmates were discussing.

or:

> Working in group is interesting. It helped me find out about my weaknesses and provided opportunities for me to sharpen my reasoning while discussing with peers. However, if I didn't first work by myself, didn't seek information and think about the problem, group work would not be much use to me.

Another student suggested a manner of learning suitable with his concerns:

> I like discussion to be applied in various disciplines, dealing with social issues at greater public concern. Each group can focus on one of the many aspects of the issue, prepare it as homework and share ideas in class. This activity, I think, will train us students to know how to investigate an issue or a problem as the first step in getting familiar with doing a thesis in the fourth year.

Indeed, students needed practice in expressing their views and beliefs about a particular topic. Students' progress could be noticed in observations made during classroom sessions.

In the first session (on cancer), students felt curious when being introduced to discussion in groups, presentation and discussion in class and the task of preparing posters. Male students appeared to be in favor of the learning tasks. They quickly and happily divided in small groups while female students did not show signals of like or dislike towards the tasks. The participant observer (main instructor) helped students form their groups so that there were both males and females in each group. The group members kept working together during all sessions. Students were to take part in group discussion, dealing with the issue of cancer prevention and treatment. The classroom environment was comfortable, open and cooperative. Three groups energetically shared ideas and argued among members. Some asked me questions to clarify some concepts or guidelines for discussion, expressed their ideas and asked for my opinions about these. Sometimes students laughed. The other two groups were not so lively in their discussion. Group members expressed ideas but did not argue further about them.

Students were rather silent during class discussion. Five male students as representatives of the five groups presented a summary of group discussion results to class, using a poster. Most male students shared ideas while no females offered opinions in class discussion. Overall, one-third of the class got involved in class discussion. All posters were illustrated with outlines and words rather than a concept map. One flaw of the discussion was that all groups were assigned to explore all aspects of the issue, thus leading to reiterating information. and failing to motivate students. Moreover, a coverage of the many aspects without restriction resulted in generating superficial student opinions. Indeed, class discussion was similar to an "ask-answer" dialogue between students and the one who presented on the blackboard, or sometimes between the teacher and the speaker, while the others listened. Other group members did not give opinions assist their fellow speaker in defending their group's views.

In the second session (on the HGP), students brainstormed to explore diverse positions on genetic testing. Most students enthusiastically suggested their ideas, others encouraged and applauded fellows' opinions. Five positions were suggested, including those of future parents, people at risk of having genetic diseases or being carriers, people who worked with exposure to mutagens, employers and insurance companies, and government. Each group selected one position to explore and supported corresponding points of view. Students actively engaged in their learning, involving female as well as male students. They sought information from handouts and shared their understanding. I moved from group to group. Students felt confident to ask me about the concept of genetic testing, presented their views and understanding, and asked me for feedback. Group presentations involved both male and female participation. In addition, group members supported the group speaker, gave supplementary ideas and defended their group's views. One third of the females shared ideas during class discussion. Class climate was lively. Students exchanged ideas with other students. However, what they agreed upon lacked depth. Several students were confused about the concept of genetic testing. Genetic testing is not being carried out in Vietnam yet, but health counselling services exist, such as counseling for couples about the risks of getting AIDS. From feedback of the observer, it was shown that students were not provided with enough basic knowledge to discuss the issue effectively.

In the third session, when investigating the mechanism of Down's syndrome, they enthusiastically offered explanations. Some students went to the blackboard drawing diagrams of meiosis to explain it. One student confused the symbol indicating trisomy (2n + 1) and triploid (3n). Others pointed out the misconception, contributed more ideas and complemented the diagrams. During the break, more students talked to me about their understanding and reasoning about the mechanism of Down's syndrome and wanted me to determine if they gave the right solutions. I explained to them about how to make a hypothesis and the way to test hypothesis. Some stayed in class, drawing diagrams and discussing with classmates about meiosis and trisomy 21. When discussing the case study of Down's syndrome and abortion, students shared opinions freely and confidently, arguing for and against abortion. In a class vote, 13 approved of abortion for a fetus with Down's syndrome, 21 were against it and 1 was undecided. Two groups preferred to write outlines on the blackboard to facilitate their presentation. When arguing the pros and cons of abortion, they confronted differing personal and moral values. Initially, male students dominated discussion in which generated two opposite sides. Those who were for abortion said that the disease was incurable and so the child and its parents would suffer an endless pain. One student mentioned the pressure of society on the child. Those who were against abortion emphasized the responsibility of the child's parents, parents' love for the child, and the right to live of a human being, even of a fetus. Assuming that female students played the mother role, I encouraged them to respond to male reasoning which were considered as the father's opinions. Female students became immersed in the flow of discussion. Four females said that they did not want to have abortion. One female mentioned the mother's affection for her child and her wish for offering best conditions to her child. She assumed two cases: if she could not afford to take care of the child well because of poor economic conditions of the family, she would choose to have abortion, and in contrast, she would keep the unborn child if the family budget was enough. In her opinion, the insufficient of public health services for Down's children put her at hard choice; yet, in both cases, the mother would feel in great pain. The whole class clapped hands to applaud her. I posed one question for those who accepted the decision to keep the unborn child: if accepting the risks of having a child with birth defects, was genetic testing still necessary? Some said no but most indicated that genetic testing was still necessary because it helped the parents face the situation better and plan positive actions. Overall, students became more familiar with the study of issues and compatible learning activities. Being engaged in a case study, students appeared to be more interested in arguing and sharing ideas. About two-thirds of the class participated actively in discussion in which more females talked (12 females of 18 females).

Teacher role

The teacher could effectively contribute to student study of issues. Firstly, the teacher was responsible for creating an appropriate and non-judgmental learning environment for students. A student estimated that group discussion was more useful than class discussion to his study. The reason was that in group discussion, all group members easily got involved in while in class discussion not all students were engaged. Another student suggested that a well-organized group discussion could provide relevant reviews for class discussion and improve the dynamics of class discussion, on the condition that the teacher played the role of facilitator to encourage all students to be involved in their learning.

The feedback questionnaire from students indicated both strengths and weaknesses of the teacher and class activities. About one-third of the class favored a classroom environment that was fun and interesting. There were many students who actively took part in discussion and class presentation. However, several students found that the class was sometimes too undisciplined, and sometimes too quiet. Not all students were engaged in learning activities. Some missed preparing the study questions or did not focus on discussion, others kept quiet and did not share ideas. The teacher attempted to encourage students to speak and ask questions, provided knowledge and explanations to some extent, and asked some questions but did not satisfy all students. Factors, such as teaching style and learning style or limitations of facilities may affect teacher effectiveness.

About half the class reported that they lacked communication skills, felt a lack of confidence when talking in front of the class, and found it hard to organize in their minds what to present. Some were not familiar with the fact that there were no right or wrong answers with regards to the issues. Several students recognized that they developed some communication skills and gradually dared to talk in class.

Despite deliberate preparation of the sessions prior to class, I felt rather nervous. It was the first time I tried the "social issues" approach in a classroom context. The participant observer of the first session commented that both the teacher and especially students were rather perplexed with the unfamiliar activities. In addition, I received feedback from several students. Students in a group interview agreed that they liked to be involved in an open and comfortable learning environment as they had in their class during the study of issues. The teacher gave varying questions that helped them expand their answers and developed understanding of the issues. Several students noticed that they were somewhat confused about the issues because the teacher did not review and draw generalizations at the conclusion of each session, and that the teacher also failed to engage all students in the learning activities. The observer of the second session (HGP) told me that I appeared to lack patience when listening to students speak and often interrupted them.

Time arrangement:

It took time to investigate the issues in depth. During the field test, time might be limited for students' study of issues. Students reported that they had to study an average of 45 hours per week, attending class every weekday, except Saturday afternoon and Sunday. On average, students spent four hours preparing at home for every eight class hours. In addition, some students had to work to earn a living while studying. One student said that he was kept very busy with all his courses. To explore an issue under study in my class, he spent about three hours reading handouts, articles and materials found in the library, and preparing the study questions. Another suggested that if there were one week available for careful preparation of the issue, discussion in class would be more thoughtful.

Learning Basic Knowledge in Cell Genetics

Knowledge enhancement

As mentioned in the previous section, scientific knowledge provided foundations for further exploration of an issue. Learning scientific knowledge was an integral part of the issue investigation process. On the other hand, the study of issues affected the way students learned basic knowledge to some extent.

Students were provided with a knowledge base related to the issues under study, involving facts, concepts, principles and mechanisms presented in handouts and articles. Such sources supplemented the lectures which presented the core of the curriculum. Dealing with a particular issue in the context of a cell genetics course, students tended to approach the controversy by exploring scientific knowledge related to it.

It was shown that students' understanding of concepts depended on their familiarity with the concepts in terms of experiences and knowledge base. Cancer and Down's syndrome were familiar from textbooks and the media. Most students felt ambiguous about the issue of genetic testing, partly because they did not obtain adequate knowledge of the structure and function of the chromosome and partly because genetic testing techniques were rather new in the Vietnamese social context. There were arguments about the concept.

Through the study of issues, students had opportunities to ask the teacher and peers about things they did not understand and were concerned about. They posed questions concerning concepts and principles such as the nature of cancer and genetic testing, or cause-effect questions, such as why so many woman got breast cancer, or why lymphocytes were chosen to explore the effects of radiation on genetic makeup. To answer these questions, they tried to find evidence in written materials. It appeared that they were interested in explaining the mechanisms of certain phenomena, in which they applied basic concepts and principles for reasoning (for example the mechanisms of the causes of cancer, of metastasis, or of the causes Down's syndrome). Students' concerns might be affected by teachers' expectations from them in science learning. In an interview with the main instructor of the course, he insisted that student assessment should focus on basic knowledge they acquired, in which mechanisms of the processes were emphasized. In addition, there were students who connected knowledge from other subject areas to clarify some aspects of the issue. For instance, knowledge of developmental biology was applied to deal with the question of the status of the four month old fetus, or to explain the assumption of nondisjunction during meiosis I rather than during meiosis II in the process of oogenesis.

In general, students attempted to build a scientific conceptual framework around the issue and expand it. However, there were problems beyond their abilities in terms of preparation time and chances for in-depth information seeking (for example, the mechanism of immunology or DNA recombinant techniques).

Evidently, through the issue study, students could learn basic knowledge from a variety of sources. Initially students' learning was mainly based on lectures and written materials as a one-way communication. Through the study of issues, they expanded their learning through a two-way communication, involving exchanging knowledge and ideas with the teachers and peers. For instance, one student assessed her outcomes as follows:

> Different individuals may understand scientific knowledge in different ways. Discussing it with peers helped me determine what I did understand and at what level I understood it.

Most students perceived that the study of issues helped them reinforce basic knowledge in cell genetics they acquired from lectures. For example, dealing with the issue of cancer, they needed to revise the mitosis and cell cycle as a basis to understand how the cell cycle was interrupted when a normal cell was converted into a cancerous one. The interactions between genes, and between genes and the environment were clarified and explored in depth when students explained the gene expression of protooncogene. Similarly, they reexamined the process of meiosis and fertilization to find out how the trisomy of 21 was generated. Moreover, they were excited about expanding their scientific knowledge.

Several students reported in the final essay that the issue study of genetic testing motivated them to investigate the incidences of other genetic diseases. Some were excited about the perspective on genetic therapy, others on restricting the propagation of genetic defects in the population. They saw that scientific knowledge was not restricted to textbooks or lectures. One student said:

> Sometimes I felt saturated with knowledge in textbooks. It is not vital, just dry information. And I like to search in the library for books of interest with knowledge different from textbooks, concerning both scientific and social problems. For me, I enjoyed reading The Double Helix, written by Watson (translated into Vietnamese). ... Analyzing an issue, I asked myself what causes generate the issue, and how to understand the issue. From that, I find the scientific knowledge acquired is relevant and not quite far from real life.

During class sessions, it was recognized that students were perplexed when interpreting the diagrams showing how a protooncogene was converted into oncogene as well as the graph showing a relationship between maternal age and Down's infants. When presenting the posters to the class, students tended to use words and phrases but rarely drew concept maps. It seemed that students were not familiar with learning science with illustrations.

Misconceptions

Sharing ideas with peers could help students confront some misunderstandings and learn from peers. In a group discussion, when investigating the genetic basis of cancer, one student suggested a perspective of splitting and deleting the protooncogene from the genome of an organism to restrict the development of cancer. Another student opposed the idea and showed that protooncogene functioned normally in a normal cell and only malfunctioned when changing into oncogene under certain factors.

Whether cancer is inherited was another concern of students. Initially, most of them thought that cancer was inherited because cancer was related to the function of the oncogene. Through argument in groups and then in class, several students identified that what was inherited was not cancer but the potential to have cancer, determined by protooncogenes. The relationships between genes, as well as between genes and environment were then clarified to support this fact. Some exceptions were pointed out based on the distinction between somatic mutation and germ mutation.

When investigating the issue of genetic testing in a class presentation, one student in the role of a representative of people who worked with risks of exposure to mutagens, identified that genetic testing was necessary for his group to detect possible damage to the genetic material. But how to proceed with genetic testing? What genes needed to be tested? He felt that all the genetic apparatus of an individual should be tested. There were arguments this point. It was impossible to test all the genome. Others indicated that the essential step was to understand the nature of a particular mutagen, and how it affected DNA and chromosomes. Such an examination would serve as a basis to determine what test should be used, and what region of DNA should be selected for testing. Another suggested that an examination of the genetic diseases related to the exposure to a certain mutagen could also help determine the appropriate test.

Attitudes toward Science and Social Issues

Prior to being engaged in the study of issues, students were asked to answer an attitude scale, concerning the enjoyment of the cell genetics course, the value of genetics to student life and society and four "issues" statements.

The "strongly agree" and "agree" scales were combined to determine the number of students who agreed with a statement. The "undecided" scale and no answer for a statement was marked as undecided.

Results of the attitude scale (Table 2) showed that:

Most students in the class enjoyed studying cell genetics and were interested in the applications of cell genetics to real life. However, nearly half the students felt that concepts and basic principles of cell genetics were difficult to understand. Most of the students wanted to work in a scientific field and believed that knowledge of genetics would be useful for their work. Of 27 students, 11 students agreed that they would like to be a genetic researcher. The majority admitted that genetics was concerned with practical problems, involving human health problems, and that every citizen needed to have some understandings of genetics.

Table 2. Results of students' attitude scale (n=27)

Enjoyment of Cell Genetics Course	DA	U	A
1. I feel the study of cell genetics is important.	1	-	26
2. Cell genetics is not interesting at all.	26	1	-
4. I enjoy studying cell genetics.	-	-	27
5. I am interested in the applications of cell genetics.	-	1	26
3. It is difficult to understand concepts and basic principles in cell genetics.	14	3	10
Values of the course for student life and for society			
For student life			
6. I don't need genetic knowledge after graduation.	23	1	4
9. I would like to apply knowledge of genetics to my work in the future.	1	4	22
11. I would not be satisfied working in a scientific field.	23	1	3
14. I would like to be a geneticist.	5	11	11
For society			
7. Human health problems are related to knowledge of cell genetics.	-	2	25
10. Discoveries in genetics do far more harm than good.	19	4	4
12. The value of genetics lies in its usefulness in solving practical problems.	1	2	24
8. Only biologists need to have knowledge of genetics.	23	2	1

	DA	U	A
13. Every citizen should have some basic understanding of genetics.	3	-	24

Attitudes toward specific issues

15. An exposure to mutagens should be restricted in a population to reduce the incidence of cancer.	3	7	17
16. We have a right to choose whether to accept genetic testing on ourselves or not.	4	-	23
17. Genetics counselors should make all decisions for couples with possible genetic problems in their unborn children.	5	7	15
18. An exposure to ionizing radiation increases the incidence of damaging genetic material.	3	-	24

Attitudes toward specific issues (results from students' final essay) (n=33)

1. An exposure to mutagens should be restricted in a population to reduce the incidence of cancer.	-	-	33
2. We have a right to choose whether to accept genetic testing on ourselves or not.	-	1	32
3. Genetics counselors should make all decisions for couples with possible genetic problems in their unborn children.	23	-	10
4. An exposure to ionizing radiation increases the incidence of damaging genetic material.	-	-	33

Regarding four statements concerning the four issues under study, a comparison of the results obtained from students' attitude scale prior to the study and of results from the final essay (Table 3) showed that: Initially, about one third of students agreed that "an exposure to mutagens should be restricted in a population to reduce the incidence of cancer". In the final essay, all students in the class agreed with the statement. It implied the importance of cancer prevention in a Vietnamese social context, as students had argued when investigating the issue.

Upon completion of the study of issues, more students agreed with the statement "we have a right to choose whether to accept genetic testing on ourselves or not", 3% of students chose the "undecided" option, while no one disagreed with the statement compared to 15% of students who chose the "disagree" response at the beginning of the study. The result was somewhat compatible with the principles of genetic testing which students suggested, such as "genetic testing should be voluntary".

In the final essay, about 50% more students disagreed that "genetic counselors should make all decisions for couples with possible problems in their unborn child" compared to the results of the attitude scale. There were 30% of students who agreed with the statement after the sessions compared to 56% of students who agreed in the earlier attitude scale. It appeared that students' responses to this statement contradicted those to the statement "we have a right to choose whether to accept genetic testing on ourselves or not". Of the students who agreed that genetic counselors should make all decisions for couples, many reasoned that the counselors were experts and could make sound decisions on the problem the couples faced.

Similar to the results for the first statement, after the sessions, all students of the class agreed that " an exposure to ionizing radiation increases the risks of damaging genetic material" compared to 89% of students who agreed with the statement before the study of issues.

In general, students' attitudes toward particular issues changed upon investigation of these issues in a positive way.

Table 3 . Percentage of students' responses for each category on four "issues" statements

Statement		DA	U	A
An exposure to mutagens should be restricted in a population to reduce the incidence of cancer.	At. Scale	11	26	63
	Essay	-	-	100
We have a right to choose whether to accept a genetic testing on ourselves or not.	At. Scale	15	-	85
	Essay	-	3	97
Genetic counselors should make all decisions for couples with possible genetic problems in their unborn child.	At. Scale	18	26	56
	Essay	70	-	30
An exposure to ionizing radiation increases the risks of damaging genetic material.	At. Scale	11	-	89
	Essay	-	-	100

At. Scale: Attitude Scale, DA: disagree, U: undecided, A: agree.

When asked about their future plan, in a demographic form prior to the study, half the students said they would like to pursue further study after graduation. Some had no ideas, and the remaining respondents wanted to get a job. The subject matter that most students enjoyed involved microbiology, biochemistry, genetics and physiology because these fields had many applications to real life, to society and industry, and could give students better employment opportunities.

Interests in science

Through the study of issues, students came to be aware of the relevance of science and as a result, they were more interested in learning science. The following three responses in final essays reflected such a view:

> I enjoy the study of issues, from which I realized the pressing problems of a real life, thus building up relevant directions and ambitions for my future career. I got practice in applying acquired knowledge to explore and analyze a real problem. I realize scientific research should be linked to social benefits.

> The study of issues helps me approach scientific knowledge in a focused way and reinforce it. Discussing social issues gave me more interest in learning, and provided me with real life knowledge which will be useful to my future work. I'd like to be free to present my feelings and understandings about a particular topic.
>
> I used to be familiar with pure science and found it to have little relevance to real life problems. The study of the issues made me think differently. I've found that scientific knowledge is somewhat useful for exploring some real life problems, such as cancer prevention, or safety for people who work in a nuclear power plant. I'm interested in human diseases that are threatening our society, such as AIDS. I enjoyed following the open conversation about the case studies of AIDS in Youth magazine. I'm seeking more information about AIDS.

During the sessions, students showed their enjoyment of the issues. After the session on cancer, some students met me and expressed their opinions and feelings. They were still not satisfied with the information and materials about cancer that they had acquired. One student asked me to provide him with specialized and in-depth materials on cancer. He would like to work with medical services and have opportunities to investigate the topic in depth.

Interests in issues

Results from the students' feedback questionnaire showed that 20 students were most interested in Cancer, 13 in HGP and 10 in Down's syndrome. Many reasons for their interests were recorded through students' responses. The majority recognized that these topics were related to real life while having scientific foundations.

Cancer and the issue of prevention and treatment, motivated most students because of large public concerns and an abundance of available information. Students who enjoyed studying the HGP topic were excited about scientific advances and future perspectives toward human life including gene testing and genetic therapy. Students felt challenged when dealing with the bioethics mentioned in gene testing, especially in the case study of Down's syndrome and abortion. It appeared that students did not enjoy the topic radiation and genetic damage. The majority said that their lack of knowledge and information in this area made it hard to follow what the speaker presented. The speaker's manner of introducing information was also critiqued. Although the majority realized the significance of the topic, students felt ambiguous about the scientific concepts and formulas introduced in the seminar. They had few opportunities to explore the issue by themselves but absorbed knowledge passively. As a consequence, only a few questions were raised after the seminar. However, from observation during the session, I saw that students paid attention to the different types of chromosomal breakage which were illustrated on visual slides. The following quotations from students responses to a feedback questionnaire reveal their beliefs:

> I felt most interested in exploring cancer. It is a severe disease and there is a great deal of public concern about it. There is lots of information about cancer in books and magazines which I find useful to draw out what I need to know.

> Cancer and Down's syndrome are the most interesting for me. They are related to real life and information concerning these topics is widely known. These factors motivate me to investigate the issues more in depth.

> I am very interested in cancer and HGP because these issues are related to real life. I find scientific knowledge concerning these issues relevant. I would like to take actions myself, and on behalf of others, help them approach these issues scientifically.

When asked about what other issues attracted their attention, students presented a wide range of issues. AIDS and environmental pollution were subjects of great concern. A student showed interest in AIDS because the issue was widely publicized through the public media (television, newspapers, communication services, etc.), and because the risks of AIDS for contemporary and future society were so huge. Environmental pollution was perceived not only as a local and national but also as a global issue. One student expressed worries about destroying the natural environment of many provinces in Vietnam due to the country's current open economic policy. Another expressed his concerns about malaria as a crucial problem of his region and other highland provinces, and related it to the surroundings, lifestyle, and human health care for residents. One student suggested a discussion on pulmonary tuberculosis. This student was in the process of seeking information about the cause, the treatment and prevention of the disease. Garbage treatment and deforestation were other real issues of interest.

In a group interview, all interviewees expressed their positive attitudes toward the social issues under study. One student said:

> I see that the issues to be studied link science with society and "real" life. Actually, learning how to solve the issues is useful to me because sooner or later, I will have to enter the workplace.

The interviewees showed their interest when talking about the specific issues under investigation. One student enjoyed most the HGP and genetic testing issue. According to him, the issue was the central theme of the remaining issues under study. However, for most students scientific knowledge concerning the issue was rather abstract and complicated. They had only acquired some general information about chromosomes from their first year and second year courses. Unfortunately, the lecture on the structure and function of chromosomes was not given prior to the study of HGP and genetic testing. It appeared that this obstacle somewhat diminished students' interest in the issue. Another student showed his excitement toward future perspectives and risks of the HGP to human life. He mentioned genetic therapy and biotechnology products and worried about the hazards of using biological weapons and releasing new organisms, the products of genetic engineering, into the environment.

One student would like to explore more bioethics, a novel aspect of modern biology. He emphasized that a scientist who had strong means in his or her hands was also a human being, and therefore, ethics was very important and should control scientific work. He was not in favor of genetic testing. In his words:

> Genetic testing, I think, has a negative rather than a positive effect. Evolution should not be interfered with by any means because natural selection will keep what is better and eliminate what is worse. However, it does not mean that scientific advances will be prevented.

All interviewees noted that cancer was the most interesting issue to them (with the exception of one student who missed this session when returning late to class after summer holidays).

It was the first lesson in which they were involved in unfamiliar learning activities, and since they were curious about these activities, they tried their best to prepare for the first session. They also were concerned about Down's syndrome and abortion. These issues gave students motivation to learn science because they were related to everyday world and were taught in a way different from lectures.

Regarding the issue of radiation and genetic damage, all interviewees admitted its significance to everyday life. They perceived that the issue was an integral component of environmental pollution, which could cause harm to living organisms, including human beings. However, the issue was not quite as interesting to them as the others had been. The reason was that the speaker provided an overload of information and that students had few opportunities to explore the issues by themselves.

Other Outcomes

Along with the study of issues and compatible learning activities, there appeared to be growth in relationships among students, and between the teacher and students. One student noted:

> I find many changes. In our class now, we feel closer and more friendly and comfortable when sharing ideas. In the same way, I find the distance between the teacher and students has become narrower, although to some extent we still keep an attitude of respect towards the teacher. I feel easier when I have something I would like to present to the teacher, without fear of being impolite with him or her as before. Owing to this, I think, students have opportunities to develop all their potential abilities.

Learning from peers was another concern of students. One student reported:

> Our concerns about an issue are not only scientific but also social and moral. I found out that everyone has strong and weak points to explore and learn. Both knowledge and life experiences can be relevant for my learning.

Teachers' View on Science Teaching

It was assumed that the teacher's view on science teaching would have certain effects on students' learning of science. Teachers tend to teach students what they consider to be essential in science education. In other words, the main objectives that the teacher fostered in a syllabus could shape the content and the manner of his/her teaching.

Two interviews were conducted with two participant observers who attended the session 1 and session 2 (Mr. V. and Ms. B.). Both participant observers as teachers emphasized the acquisition of knowledge as the essential objective of biology teaching. From their view, the teacher played an important role as a knowledge transmitter. A great concern of Mr. V. was about what knowledge should be selected for disseminating to students in the restricted time allowed for the syllabus. According to him, the mechanism of a process or a phenomenon, for example, the mechanism causing Down's syndrome, was crucial in learning basic knowledge and should be privileged in lectures. Ms. B. gave reasons for the effectiveness of lectures:

> I think that with the present learning style and thinking style of our students, traditional teaching,... I mean giving lectures, is more effective than organizing discussions. The reason is that at least students can acquire basic knowledge through lectures. For example, with the two study questions on genetic testing and the Human Genome Project, if the teacher spends time to preview principal ideas as minilectures before questioning, students would understand the problem more clearly.

Regarding the teaching of a concept, Ms. B. clarified her view:

> For the basic concepts, the teacher should give precise definitions to students. For example, on the concept of genetic testing, the teacher should explain it clearly, and students accept it as a direction to guide discussion. The extent of discussion should be limited to their own views and the manner of problem solving, but not to the principles.

Such comments might imply that science should be taught as a product rather than a process.

There existed a paradox between what the teacher taught and what he/she expected from students. Assessing students' ability, Ms. B. indicated that students were worst in problem solving skills, in applying basic knowledge to explain a certain phenomenon. However, the teacher intended to teach students basic knowledge rather than how to learn and seek information. Students were expected to develop problem solving skills but were not taught them.

Regarding student assessment, Mr. V. emphasized that in an examination, it was satisfactory that students understood the central theme of a problem and explained the basic principles and mechanisms related to the problem clearly.

This model of science teaching was restricted to providing students with basic knowledge and then asking them to reflect their understanding of what they learned. Mr. V. was concerned about teacher training, but was inclined toward improving on the teacher's major in science rather than in teaching. In any case, scientific knowledge, both basic and advanced, for both students and teachers was the primary concern of the teacher.

When asked about the potential for incorporating the issues into the syllabus, both teachers advocated the approach. However, Ms. B. insisted that the study of issues should be considered as an extracurricular activity and only offered to third year students or higher. She saw the process of learning as comprising two main stages:

Firstly, students should acquire adequate basic knowledge. The teacher provided such knowledge via lectures. This was especially important to the first and second year students.

Secondly, students applied acquired knowledge to solve problems. The study of issues was one way for students to practice applying basic knowledge.

Ms. B. said:

> Anyway, basic knowledge should be taught adequately and the constrained time allotted in the syllabus should serve for the transmission of basic knowledge. The study of issues can be organized in lab hours, or some extra hours can be added for such an activity if there is no lab.

The teachers were confronted with the great pressure of a massive body of knowledge and constrained time in the curriculum, and thus needed to make a choice. A shortage of materials for students also limited the teachers in expanding their teaching strategies beyond lectures. In addition, both teachers were not satisfied with current laboratory situation. They felt it difficult to manage lab experiments for students due to the poorly equipped labs. In such a context, they found that lab hours were not conducive to student learning. Ms. B. suggested the strategy of providing case studies for students to solve as a manner of "minds-on" practice to partly replace lab hours.

Mr. V. perceived the study of issues as complementary to basic knowledge, providing opportunities for students to obtain recent information about the applications of scientific knowledge to industry and society. Therefore, to some extent, the teacher could modify time allocations for particular units in a syllabus to introduce some relevant issues to students.

Playing the role of a participant observer in the issue study of genetic testing, Ms. B. saw some significance to students' learning activities. Students had opportunities to practice in applying acquired knowledge to real life problems and using logical reasoning. Through students' expressions of ideas, the teacher could help them recognize errors in their thinking or their methodology to solve a problem as well as evaluating students' strengths and weaknesses. Ms. B. suggested a strategy to engage students in the study of issues. The teacher could prepare a list of questions , involving case studies concerning a particular issue and then assign to students individually or in pairs or triads to investigate a question. In other words, she felt the issue under study should be limited to certain aspects and should be explored in terms of a set of questions. Students could prepare the questions as homework and present them to the class for a predetermined time, for example five minutes per question. Sharing ideas among peers could then follow on the basis of these presentations.

Summary of the Findings

Overall, data analysis showed that students appeared to enjoy investigating social issues in a cell genetics course. Throughout the study of issues, they had opportunities to apply basic scientific knowledge to real-life problems, and discovered the complexity of the issues in terms of an exploration of differing points of view on an issue and of the difficulties involved in making a sound decision. The issues were examined in diverse aspects, involving scientific, moral and humanistic considerations. As a result, students perceived the relevance of science to everyday life and society beyond the classroom.

Engaged in their learning, students made progress in several dimensions, including:

- Enhancing and reinforcing basic knowledge they acquired in biology courses,
- Perceiving misconceptions,
- Practicing some thinking skills, such as questioning, interpreting and reasoning,
- Showing interest in science,
- Enjoying sharing ideas with peers and developing communication skills,
- Developing student-student and teacher-student interactions.

Students' learning about social issues were constrained by several factors, both extrinsic and intrinsic, such as learning style, teaching strategies, classroom environment, time scheduled and a shortage of references related to the issues.

Chapter 6
Discussion and Implications

This chapter begins with a brief overview of the problem and then discusses the findings presented in the previous chapter. It also addresses the limitations of the study and its implications for further study in science education.

The first purpose of the study was to develop an instructional design related to the study of issues surrounding human diseases and genetics as supplementary activities for a cell genetics course. The design was then tested with third year biology students at Dalat University to investigate how students responded to the study of issues, considering their learning of scientific knowledge and social issues as well as their changing attitudes toward science. Data collection from different sources, including students' feedback questionnaires, a group interview with students, classroom observations, and students' writings and discussions were analyzed descriptively, providing response to the implementation of the instructional design. Discussion of these findings may highlight some of the strengths and weaknesses of the instructional design, and its implications for science education at Dalat University.

Discussion

Students' concerns and curriculum development

Students showed their interests in exploring the interactions of science, technology and society, and the applications of science to real life problems. From the teacher observer's view, students' abilities to solve problems were not previously considered to be of a high level, with only lectures providing students with a knowledge base. This situation revealed a deficiency in the present curriculum development, in which students' needs and concerns as one of the essential factors contributing to the structure of the curriculum were forgotten. The acquisition of narrowly defined scientific knowledge as an academic preparation was considered to be a primary objective of the present curriculum.

Students' concerns included personal, local and global problems which had scientific foundations. These could be a valuable source for teachers' consultation in designing and developing pertinent topics for a science syllabus. Generally, incorporating science related social issues in a science curriculum was suitable and matched students' needs.

Students' responses to the study of issues

Unusual learning activities can arouse students' curiosity and initially promote their engagement in such activities. Students appeared to have more motivation in learning when challenged with a controversy and given opportunities to explore or discover some thing unknown on their own. Yet they sometimes felt anxious or lost their way if faced with difficult knowledge or a complex problem.

It is recognized that experiences and a knowledge base can facilitate students to explore an issue and obtain an understanding of it. In addition, experiences can help students construct their knowledge more easily. Actually, experiences and knowledge can be acquired in diverse ways. Students can search it out on their own through observing phenomena outside the classroom, collecting information from public media, written materials or self-study. Otherwise, the teacher can enrich students' learning environment with varying activities, providing opportunities to learn. Coupling different teaching strategies, for example, lectures, field trip, talks with people working in the field, or films can stimulate students' involvement in their learning.

Further, students seemed to find it easier to discuss a more specific topic like a case study of Down's syndrome and abortion rather than a general topic, such as whether genetic testing should be voluntary or mandatory. Indeed, prenatal diagnosis of Down's syndrome is a case of genetic testing. Similarly, an examination of chromosomal anomalies in human lymphocytes in relation to a radiation treatment as another type of genetic testing could illuminate the general issue.

Throughout the study of issues, students generated various questions. This was a dynamic way to promote their learning, from exploring the meaning of concepts and principles to posing new problems which required a synthesis, analysis and further research. Students showed interest in connecting knowledge from other courses (for example, developmental biology) to interpret a phenomena. Such a behavior reflected a positive attitude toward learning science.

It was seen that as students discussed an issue, their interest was aroused, their need for more information increased and further problems were generated. Hence, it is possible to integrate learning of basic knowledge and thinking skills in the study of issues rather than separating them into two distinct stages.

There was evidence that sharing ideas facilitated an exploration of different points of view on an issue. Initially, students felt uneasy about talking in class, but fairly comfortable in exchanging knowledge and opinions in small groups. This increase in comfort was especially true for female students. As the sessions proceeded, students became familiar with the discussion format. During class presentation and discussions, they listened to peers' viewpoints and tried to seek evidence and reasons to argue and defend their own views. Dealing with the issues, students not only learned scientific knowledge but explored beliefs and value judgments. Personal, moral, cultural and economic concerns were raised through the study of an issue. The complexity of an issue confused a few students. The majority discovered that it was acceptable to have a no right or wrong solution for an issue.

However, they were perplexed in their attempts to judge varying views. They were familiar with the idea of having right answers for science problems, where the teacher often defined whether the answer was right. Such habits might be the result of traditional teaching in which science was seen as unproblematic and value-free.

Students found it more enjoyable communicating in discussion among peers and with the teacher than simply receiving knowledge from the speaker or the teacher. Attending a lecture given by the main instructor, I saw students attentively listening and taking notes. The class was quiet and disciplined. Students felt tired after a long class and did not raise questions when the teacher invited them to ask.

Guidance and feedback from the teacher was important to students' learning. Students received little guidance on how to write a report and how to read materials, and not enough feedback on such activities. It might be for these reasons that students found that these activities were not very relevant to their learning.

Participants in the study were those who successfully passed a transfer examination and the majority would like to pursue scientific work in the future. Not surprisingly, they showed positive attitudes toward science, had interest in the applications of science to real life problems and to their future career, and hence enjoyed investigating the issues.

Overall, some general comments can be drawn from the study as follows:

- Incorporating social issues surrounding human diseases and genetics in a cell genetics course was shown to be applicable to the third-year biology students at Dalat University. Within the existing syllabus, the teachers could modify the structure of some units and select appropriate instructional strategies to their students.

- The issues which had foundations in science and were related to real life could serve as a component of a science syllabus. Students showed interest in investigating such issues by being engaged in several learning activities, including group discussion, role play, case study, and class discussion.

- Experiences and knowledge base in science were found to help students approach the issues. Throughout the study of issues, students attempted to explore scientific knowledge associated with the issues. Meanwhile, they had opportunities to enhance, and reinforce their acquired knowledge, and discover some misconceptions. They also learned to pose questions and seek answers through logical reasoning.

- Beyond scientific aspects, students tried to explore different points of view on the issues. Sharing ideas among students revealed differing beliefs and values, concerning personal, moral, cultural, and other dimensions.

- Through the study of issues, students perceived the relevance of science to real life and society which appeared to increase their interest in science. Studying the issues in a cooperative context, they developed communication skills and increased interactions among peers and between teacher-students.

Limitations of the Study

Several flaws in the instructional design were elicited during the field trial as follows:

- The issues chosen were rather general, such as cancer prevention and treatment, or genetic testing and the Human Genome Project. Students failed to focus in depth on any specific aspects of the issue in the limited class time.

- The session on ionizing radiation and genetic damage was carried out, giving few opportunities for students to explore the issue concerning the safety and risks of radiation. Actually, the issue raised was rather abstract to students and left out of discussion during class period.

- Resources concerning the issues which were provided for students were somewhat restricted. Articles assigned to students were translated from foreign languages into Vietnamese, but did not originate in a Vietnamese social context. Films or visual aids were not used, except for a set of microscope slides which were shown to students in a seminar on radiation and genetic damage.

- Learning activities proceeded with mixed success, especially near the beginning of the sessions. Students felt curious when taking part in unfamiliar class activities while the investigator had few experiences in acting as a facilitator in a classroom setting .Time allocations for these activities often were not strictly followed because students did not complete the tasks in class time.

- In addition, the schedule of the whole course differed from the original design. As a result, students encountered some difficulties in the study of issues, such as insufficient preparation time on the issues, or knowledge base in terms of lectures which were not provided in advance to facilitate students in exploring the issues.

- Conducting the study for a short time, the investigator failed to give timely feedback to students on written reports and the final essay. An exploration of how students read materials and processed information was missed. Such a study might be a useful tool to assess students' thinking skills.

- Students appeared to be poor at applying concept maps, graphs and charts to conceptualize their learning. It might be beneficial to develop some student-based activities which assist them in using visual tools to learn science.

Regarding the empirical study concerning the implementation of the design, there existed several limitations as follows:

- The scope of the study which was restricted to a small sample of students was narrow. Hence, results of the findings should be regarded as preliminary analyses which provided evidence for the potential of the "issues" approach in science education and offered some experience in designing student-based activities. It may serve as a foundation for future larger studies on the topic.

- Students' responses and statements in varying sources of data (interview, essay, discussion, etc.) were recorded in Vietnamese and then translated in English by the investigator herself. Although she tried her best to keep the statements faithful to the original, some deficiencies of translation could not be avoided. Due to the short duration of the field test in Vietnam, transcripts of students' responses were not given to students to check the accuracy or clarify unclear statements. Concurrently, follow-up conversation with students after the sessions and group interview could not be conducted.

Implications

Students as participants of this study showed interests in learning science and its relevance to the individual's life and to society. Hence, it was the teacher responsibility to nurture such students' positive attitudes by enriching their learning environment and engaging them in conducive learning activities. The study suggests that the "issues" approach is one available way of helping students obtain a more holistic view on science. Concurrently, the approach might provide opportunities for teachers to explore and expand their repertoire of teaching strategies beyond lectures so that their science teaching becomes more effective.

Based on the results of data analysis and discussion, the implications for further study are offered as follows:

- It is desirable to investigate and apply the "issues" approach to other disciplines in biology particularly and in science generally in higher education in Vietnam. Results from such empirical studies which attain in a Vietnamese schooling context will provide some generalizations of the perspective.
- In addition, it is worth exploring the potential of incorporating social issues into the science curriculum in secondary schools in Vietnam.

- An exploration of students' interest and concerns should be conducted prior to designing and developing an instructional plan focusing on the study of issues. In a similar way, an exploration of available resources needed to the study of issues is required, including searching out materials, contacting concerned people or agencies and collecting available information from public media in a local context.

- An issue can be analyzed in divergent aspects, and a list of questions on the issue can be generated by both teacher and students by brainstorming. It may be beneficial to encourage students to work in groups and to have each group select one aspect of the issue to investigate.

- Learning activities should be designed in a manner that involves students in practicing problem solving and decision making skills. It may be desirable to have students do their own research by investigating a specific question related to the issue in depth. They could design and carry out their plan to solve the problem, including making observations, collecting data, doing experiments, analyzing data, and communicating their findings. In this situation, the study of an issue could not be limited to one class period but would be carried out throughout the course.

Regarding the local context of the Department of Biology at Dalat University, the perspective of integrating social issues in science curriculum is available. Third-year biology students have to take a short-term two week course, called Combination Practice (Thuc tap ket hop), which give them opportunities to practice doing research. Students are to explore a particular problem, design and carry out experiments, and interpret the findings in terms of oral and written reports. For my further study, it is feasible that I might cooperate with my colleagues to develop an instructional design focusing on the investigation of social issues which are compatible with the above-mentioned course.

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Appendices

Appendix A
Consent form from Department

DALAT UNIVERSITY
FACULTY OF SCIENCE
DEPARTMENT OF BIOLOGY

CONSENT FORM

August 20, 1995

In July 1995, Ms.Nguyen Bich Lien submitted a proposal entitled "social issues as theme in bidogy teaching" to the Department of Biology, Dalat University. She would like to do her study with the third-year students belonging to the Department. Her instruments to be used in the study are questionnaire, observation, interview and students'written - ups.

On behalf of the Department of Biology, I agree to let Ms. Lien carry out her project as proposed during September and October, 95, and will provide her with available conditions to complete it.

Dean of the Department of Biology.

Mr. Dao Trong Phuong

Appendix B

I. Introduction letter to students

To students,

You will be taking cell genetics as an advanced course of 45 hours in this first semester of the second stage.

You will be attending lectures given by the main instructor concerning basic and extended knowledge.

In addition, I will offer you a set of learning activities related to the issues of human diseases and genetics, as supplementary part of the course. The issues will encompass four topics that relate to human life and society. The issues have no right or wrong answer, but are explored and analyzed in diverse perspectives, including controversial ones (see attached list of content and schedule).

You will study basic knowledge in advance and seek more information related to these topics individually or in a group. Learning activities involve reading articles and materials, group discussion, class discussion, class presentation and writing short thinking pieces.

The purpose of such activities is to assist you in getting actively involved in your learning, consolidating basic knowledge and applying scientific knowledge and other knowledge to analyze the topics from different perspectives. You are also expected to clarify your own points of view, defend it and suggest possible solutions for the problems upon consideration of their consequences.

You will have opportunities to explore the human, social and environmental aspects of a scientific problem to gain a holistic view on science in a cooperative context.

I am doing a Master's thesis on science education, and am very interested in improving the quality of the curriculum and instructional methods in science teaching. The instructional plan described is part of the work I pursue.

The success of the work depends upon your contributions. I would like to invite you to participate in this study.

I would be pleased to get your opinions and feedback from your response to questionnaires, expression of your feelings and beliefs, participation in classroom activities, and attendance at a group interview.

The data obtained will be used to evaluate the effectiveness of the curriculum, and the effect of teaching and learning strategies on students' science learning.

Thank you very much for your contributions. I wish you great success in your studies.

Dalat, September 1995

Nguyen Bich Lien

II. Cell genetics (Cytogenetics) syllabus (45 hours - 3 credits)

WEEK 1 (Sep. 11 - 16, 1995)

Unit I (6 hours): Cellular organelles and their genetic characteristics.

Unit II (3 hours): Cell cycle and mitosis.

Supplementary topic (3 hours): Cancer: from prevention to treatment.

WEEK 2 (Sep. 16 - 23, 1995)

Unit III (3 hours): Meiosis.

Unit IV (6 hours): Structure and function of the chromosomes.

Supplementary topics (3 hours): The Human Genome Project: genetic testing and its controversy.

WEEK 3 (Sep. 25 - 30, 1995)

Unit V (4 hours): Chromosome mutation: changes in number of chromosomes.

Supplementary topics (3 hours): Down's syndrome: prenatal diagnosis and abortion

WEEK 4 (Oct. 2 - 7, 1995)

Unit VI (4 hours): Chromosome mutation: changes in structure of chromosomes.

Supplementary topics (3 hours): Ionizing radiation and genetic damage: safety and risks.

WEEK 5 (Oct. 9 - 14, 1995)

Unit VII (3 hours): Cytoplasmic inheritance.

Unit VIII (3 hours): Evolution of the genetic apparatus.

Review.

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ASSESSMENT CRITERIA

Class participation, written reports and final essay (concerning the study of issues)	25%
Midterm	25%
Final exam	50%

Appendix C

I. Consent form for attending the study

I am pleased to participate in the study entitled The social context of genetics education in Vietnam: a case study at Dalat University conducted by Ms. Nguyen Bich Lien.

I understand that the purpose of the study is to apply and evaluate an instructional model for biology teaching in higher education, in terms of its effectiveness on science learning.

I am pleased to participate in classroom activities, including discussion, class presentations, and report and essay writing.

I agree to: (please check if you agree)

_____ reply to the students' attitude toward cell genetics.

_____ let the teacher audio-tape my group discussion in class.

_____ attend group interviews with the teacher concerning my opinions and feelings about the instructional model.

_____ let the teacher audio-tape the group interview.

_____ reply to the questionnaire on students' opinions about the instructional model.

I understand that the data obtained are part of the study and will be held in confidence. I understand that I can contact Ms. Nguyen Bich Lien, if I have any questions or suggestions related to the conduct of the study, and I may examine the report on the results of the study. I understand that I can withdraw from the study at any time.

Signature of the attendant Date

Signature of the researcher Date

II. Demographic form

Name:

Age: Gender:

Address before entering the university:

District: City: Province:

Occupation before entering the university:

Special area:

Transfer exam result:

Completion of General Degree at:

Discipline(s) of interest:

Reason:

Plan after graduation:

Appendix D

Students' attitude scale

Please circle the response that most closely reflects your feelings.

(SA: strongly agree, A: agree, U: undecided, D: disagree, SD: strongly disagree)

Enjoyment of Cell Genetics Course	SD	D	U	A	SA
1. I feel the study of cell genetics is important.	O	O	O	O	O
2. Cell genetics is not interesting at all.	O	O	O	O	O
3. It is difficult to understand concepts and basic principles in cell genetics.	O	O	O	O	O
4. I enjoy studying cell genetics.	O	O	O	O	O
5. I am interested in the applications of cell genetics.	O	O	O	O	O
Values of the course for student life and society					
6. I don't need genetic knowledge after graduation.	O	O	O	O	O
7. Human health problems are related to knowledge of cell genetics.	O	O	O	O	O
8. Only biologists need to have knowledge of genetics.	O	O	O	O	O
9. I would like to apply knowledge of genetics to my work in the future.	O	O	O	O	O
10. Discoveries in genetics do far more harm than good.	O	O	O	O	O
11. I would not be satisfied working in a scientific field.	O	O	O	O	O
12. The value of genetics lies in its usefulness in solving practical problems.	O	O	O	O	O
13. Every citizen should have some basic understanding of genetics.	O	O	O	O	O
14. I would like to be a geneticist.	O	O	O	O	O

Attitudes toward specific issues	SD	D	U	A	SA
15. An exposure to mutagens should be restricted in a population to reduce the incidence of cancer.	O	O	O	O	O
16. Genetics counselors should make all decisions for couples with possible genetic problems in their unborn children.	O	O	O	O	O
17. We have a right to choose to accept genetic testing on ourselves or not.	O	O	O	O	O
18. An exposure to ionized radiations increases the risks of damaging genetic material.	O	O	O	O	O

Appendix E
Guidelines for discussion

You are reminded that the issues under study are controversial and have no right or wrong answers. You should investigate the issue and consider differing viewpoints that might be associated with scientific, social, economic, cultural, and other dimensions as a basis to make decision, or to choose a best solution for the problem in your point of view.

There are four main types of decisions :

1. An impulse decision is made quickly without thinking or learning the facts. The result is often a surprise when consequences are learned.
2. A habitual decision is made strictly out of habit ("That's what I always do"). Other choices are not considered.
3. A non-decision is no decision at all. The person thinks about the choices but can't decide (perhaps out of fear of making the wrong decision). Other people may take over and make the decision, or a decision may be forced when time runs out.
4. A careful decision is one made after considering choices and gathering facts. The person is either happy with the results, or learns from them and so becomes more confident in decision making. (Ministry of Education, British Columbia, 1986, p. 44)

This is the type of decision that you will have the opportunity to practice when participating in class activities.

<u>Practical procedures in decision making</u>:

1. Define the issue and determine what decision must be made.
2. Gather and organize information
   (from newspapers, periodicals, television, fieldwork, etc.)
3. Obtain information from sources with different points of view.
4. Analyze and evaluate many perspectives based on the data obtained.

5. Choose the best alternatives in the light of your own values and reasoning and predict the consequences of your decision.

You will be involved in group and class activities, involving discussion, role playing or debate. You are encouraged to express your own perspectives and exchange ideas freely, as well as to show respect for your peer's opinions.

Appendix F

Classroom observation guide list

The following questions shape a classroom observation framework:

Classroom atmosphere

How do students react when they are informed about the intended learning activities? How is the classroom organized? (class map). Is the class noisy? Is it disciplined? Do students feel free to attend class activities?

Role of teacher

How does the teacher guide learning activities? How does the teacher help each group in its tasks? What kind of information does the teacher give students?

How does the teacher react towards students' suggestions and questions? How does the teacher encourage students to talk? What kind of questions does the teacher ask? Does the teacher allow time for students to answer questions? Does the teacher judge student responses?

Attitudes and behaviors of students in learning

How do students listen to the teacher? to others? How do students share ideas in a group? How do students present in class?

What kinds of information do students often express (facts, opinions, beliefs, etc.)? What percentage of students get actively involved in class activities? Do students use materials to support the discussion?

Appendix G
Interview guide with observers

A set of questions was structured as a framework for interviews with the observers as follows:

Feedback on observation

1. What do you observe about:

classroom atmosphere? classroom management? students' attitudes when participating in the learning activities? group work? How students' ways of function in their groups and in class?

2. How useful do you think these learning activities are to students' learning?

3. Overall, how do you evaluate these learning activities? Can they be applied in a classroom setting? What needs to be modified? What role should the teacher play?

Teacher's views on science teaching

1. What do you think are the main objectives in science teaching? In your opinion, how could we achieve such objectives?

2. What do you think about infusing social issues into a science course? Is it necessary? If so, at what levels, and in what way?

3. How can the teacher evaluate student learning? What aspects of learning should be evaluated?

4. What are your experiences in teaching science? What difficulties have you faced in teaching science?

Appendix H

Students' opinions about teaching social issues

Please select the answer closest to your own view or give a brief explanation.

Question 1: How effective were the following learning activities to your study ?

	Very effective	Effective	Not very effective	Completely ineffective
(1) Attending lectures	---	---	---	---
(2) Discussion				
+ in group	---	---	---	---
+ as a whole class	---	---	---	---
(3) Seminar	---	---	---	---
(4) Class presentation	---	---	---	---
(5) Reading materials	---	---	---	---
(6) Writing report	---	---	---	---

Question 2:

2.1 How interesting were the topics in discussion and seminar ?

	Very interesting	Interesting	Not very interesting	Completely uninteresting
(1) Cancer	---	---	---	---
(2) Human Genome Project	---	---	---	---
(3) Down's Syndrome	---	---	---	---
(4) Radiation and genetic damage	---	---	---	---

2.2 Which topics are you most interested in ? Why ?

2.3 Which topics are you least interested in ? Why ?

2.4 What are other social issues that you are interested in ?

Question 3: In the following resources, which are most useful to you, when investigating the topics in discussion ?

(1) Textbook	---	(6) Experts	---
(2) Lectures	---	(7) Teachers	---
(3) Handouts	---	(8) Friends	---
(4) Periodicals	---	(9) Other resources (please specified)	---
(5) Radio, television	---		

Question 4: Do you feel comfortable when attending :

	Very comfortable	Comfortable	Not comfortable	Not comfortable at all
(1) Group discussion	---	---	---	---
(2) Class discussion	---	---	---	---

Question 5:

5.1 What are the strong features of the instructor's teaching ?

5.2 What are the weak features of the instructor's teaching ?

Question 6:

6.1 What are the strong features of class activities during the study of issues ?

6.2 What are the weak features of class activities during the study of issues ?

Question 7: What difficulties do you have,

7.1 when preparing the topics ?

7.2 when attending the learning activities in class ?

Question 8: What have you acquired after attending the learning activities (discussion, seminar, etc.)? (e.g. knowledge, the way to express ideas, learning from peers, etc.).

Question 9: Your other suggestions, if any.

Thank you for exchanging and contributing your ideas.

Appendix I
Group interview guide with students

A set of questions that serves as a framework for group interview with students is structured as follows:

<u>Students' interests and concerns</u>

1. What were your concerns and interests when taking a science course?

Probes: Is the acquisition of knowledge important? What do you think about studying social issues?

2. Compared to traditional teaching (the teacher talks and students listen and take notes), how did you feel when attending different learning activities (discussion, presentation, role playing, etc.) to study the issues?

Probes: Which activity did you enjoy? Why? What do you think about working in group? When working in group, could you express yourself? If there were any difficulties, could you explain why? What could the teacher do to help students get involved in the study of issues?

<u>Issue study and understanding of basic knowledge</u>

3. What do you think about the relationship between the study of issues and understanding of basic knowledge?

Probes: Could you apply basic knowledge to analyze an issue under study? Would you find any complementary of the study of issues with learning basic knowledge?

4. How did you cope with an issue?

Probes: How did you explore an issue? How did you gather information and uses resources? What were your experiences in solving a problem? What about sharing ideas among peers? What about exploring others' points of view? How did you arrange time for the study of issues? How did you make a decision on an issue?

5. What were your impressions when studying the issues?

Probes: Which issue did you enjoy ? Why? Which issue were you not interested in? Why?

Students' outcomes

6. What did you learn from the study of issues with different learning activities?

Probes: knowledge? problem solving? communication skills? peer relationship? teacher-students' relationship? interest in studying science?

Recommendations

7. Weaknesses of the learning activities? What aspects were needed to be improved?

Appendix J
Resources for topics

Resources for topic 1

Handout

Major concepts and principles are introduced in the handout, including:

1. Some characteristics of cancerous cells: malignancy, tumor, metastasis.

2. Some mechanisms of cancer:

- Cancer cells escape from control mechanisms of cell division,
- Somatic mutations can form cancerous cells: proto-oncogene, oncogene, tumor-suppressor gene,
- Chromosome aberrations and cancer,
- The complexity of carcinogenesis.

3. Causes of cancer: virus causing cancer, carcinogen

Article:

Phong van Giao su Leon Schwartzenberg (1991). Nguoi dua tin Unesco, 7, 4-9

[Interview with Professor Leon Schwartzenberg. The Unesco Courier]

The article deals with the following points:

- What is cancer. Some misconceptions
- Cancer treatment: surgery, radiation therapy, chemotherapy, immunotherapy
- Attitudes of physician toward patients with cancer
- Euthanasia and its controversial nature

Study questions:

1. Explore current situations of cancer development in Vietnam (facts from newspapers, magazines, health bulletin, talk with physician, etc.): types of cancer, cancer death rates and gender,, and age, cancer survival rate, patient services, environmental cancer risks, etc.

2. There are many kinds of cancer and many possible causes of the disease. For example, smoking causes most lung cancers, overexposure to ultraviolet rays in sunlight causes most skin cancers or a high-fat, low-fiber diet is proved to be a factor in breast, colon, and prostate cancers.

- What do you think about cancer prevention in terms of public health?
- Of cancer prevention, diagnosis and treatment, which do you think should be emphasized? Give reasons based on scientific knowledge. Consider other concerns: economic, environmental, educational, etc.
- What kinds of lifestyle changes do you think could reduce the risk of cancer? Give evidence and plan actions on it.
- Is cancer prevention (diagnosis, treatment) an individual matter or social matter? What kinds of prevention (diagnosis, treatment) programs could be initiated or strengthened?

3. What is euthanasia?

Explore the pros and cons of euthanasia (for example, patients', their relatives' and physician's view).

Clarify your own judgment toward euthanasia.

Resources for topic 2

Handout

Major concepts and principles are introduced in the handout, including:

1. Human karyotype

2. Scientific techniques to construct the human genetic map: family pedigrees, chromosomal banding patterns, somatic-cell hybridization, recombinant DNA and related techniques for mapping genes

3. The Human Genome Project (HGP)

- Structure of the project and its research trends
- Significance of the HGP toward basic science, and human health programs

3. Issues generated from the HGP: bioethics of genetic therapy, genetic screening

Articles:

1. Ibanes, S. G. (1993). Phong van James D. Watson. Nguoi dua tin Unesco, 10, 4-7 [Interview with James D. Watson, The Unesco Courier].

The article deals with the following points:

- Significance of the discovery of DNA
- The need for disseminating new information and discoveries in science around the world, including less developed countries
- Perspectives of the Human Genome Project
- Misuses of genetic information from HGP - risks and hazards

2. Kutukdjan, G. B. (1994). Unesco va dao duc sinh hoc. Nguoi dua tin Unesco, 9, 23-25 [Unesco and bioethics, The Unesco Courier].

The article deals with the impacts of HGP advances on human life and society, generating bioethical issues such as genetic testing and genetic therapy. The risks and benefits of the issues are considered in relation to several genetic disorders, and with diverse positions.

Study questions:

1. Will there be anything left for genetic researchers to do once the Human Genome Project has determined the nucleotide sequences of all of the human chromosomes? Explain.

2. What is genetic testing?

What is genetic testing used for? Should genetic testing be voluntary or mandatory? How should personal genetic information be used? Answer these questions while assuming diverse possible points of view. For example, should employers or insurance companies have access to genetic testing information of their employees and clients? Why or why not? Is there any obligation for people and future parents who might have risks of genetic disorders to undergo genetic testing,? Why or why not?

3. Based on arguments in question 2, suggest some principles for genetic testing (one to three principles) to prevent abuses.

4. Genetics problem:

Imagine that one of your parents suffered from Huntington's disease. What would be the probability that you, too, would someday fall victim to the disease? Would you want to be tested for the Huntington's disease allele? Why or why not? Suppose you tested positive for the presence of the Huntington's allele. In what ways would this information change your life? (Campbell et al., 1994, p. 252).

Resources for topic 3

Handout

Major concepts and principles are introduced in the handout, including:

1. Facts information about Down's syndrome: phenotype, statistics concerning proportion, life durance of people having disease, graph showing relationship between maternal age and Down's infants.

2. Prenatal testing: amniocentesis and chorionic villi sampling.

3. Mechanism causing Down's syndrome

Article:

Galjaard, H. (1994). Chan doan truoc khi sinh: ky su ve mot su song duoc bao truoc. Nguoi dua tin Unesco, 9, 17-19 [Prenatal diagnosis: a chronicle of a predictable life, The Unesco Courier].

This article addresses the perspectives of prenatal diagnosis on genetic anomalies and explores the attitudes of people who have risks of genetic diseases toward prenatal diagnosis, in relation to other concerns such as religion, culture, etc. Perceptions and attitudes toward abortion reflect the dilemma of the issue.

Study questions:

1. Explain the mechanism causing Down's syndrome, considering the two cases - nondisjunction in meiosis I and nondisjunction in meiosis II.

2. Explain why the incidence of Down's syndrome appears to increase with the increasing age of the mother, and why it appears in highest proportion compared to other genetic disorders.

3. Case study:

A couple has two kids, a ten-year boy and a seven-year girl. At the age of 36, the wife becomes pregnant for the third time. Because of her age, she would like to have a prenatal diagnosis to determine if the fetus has any defects.

Result of prenatal diagnosis in the 18th week shows that the fetus is positive in Down's syndrome. Both husband and wife are shocked. Should she have an abortion or should she have the baby?

The wife feels frustrated with the fact that her infant will have Down's syndrome. She worries that the relationships in the family will be worse, relationships between her and her husband and between the child and its sibling, and she worries about a hard life for the child. She would like to have abortion.

The husband feels pain about the idea of having the fetus aborted. He feels responsible for his unborn child, although it has defects. Although, prenatal testing shows that the fetus is Down's syndrome, he knows that no one can be sure how severe retardation and birth defects will be. There is evidence that Down's children can learn to read and had a normal life. He would like his infant to be born and taken care of.

Assuming you are counselor and understand genetics, what information and reasons would you offer them to help make the best decision in their situation?

Consider such concerns as: (i) state of the disease; (ii) is the four-month fetus considered a human being? is abortion at this period ethical? (iii) how to prepare life for the infant and the family if the baby is carried to full term?

Resources for topic 4

Handout

The handout illustrates the seminar topic "Techniques to analyze the karyotype of human lymphocytes - An exploration of the relationship between the frequency of chromosome aberrations and dose, dose rate and the nature of ionizing radiation", with some outlines on:

- Classification of chromosome aberrations;
- Analysis of karyotype of human lymphocytes treated with different kinds of ionizing radiation;
- Exploration of the relationships between the frequency of chromosome aberrations and dose, dose rate and nature of ionizing radiation;
- Significance of the study;
- Results and proposal for subsequent researches.

Scientific report

An exploration on the distribution of chromosome aberrations and their frequency in a sample of residents living in Dalat.

Study questions

Consider the risks of ionizing radiation on human health. Give evidence for it.

Consider safety policies in a nuclear power plant.

Connect this to the issue of environmental protection.

Final essay

A. The four following statements are cited in the attitude scale you replied:

1. An exposure to mutagens should be restricted in a population to reduce the incidence of cancer.

2. We have a right to choose whether to accept genetic testing on ourselves or not.

3. Genetic counselors should make all decisions for couples with possible genetic problems in their unborn children.

4. An exposure to ionizing radiation increases the risks of damaging genetic material.

After studying the issues, what do you think about these statements? Do you agree or disagree with them? Give reasons to support your position.

B. What are your impressions after taking part in this study of issues?

Appendix K

Coding results of feedback questionnaire (n=33)

Key codes	Number responding
Learning activities to be effective (Theme 1)	
Attending lectures	33
Discussion / group	32
Discussion / class	30
Discussion / group / comfortable(very)	6 (26)
Discussion / class / comfortable(very)	15 (16)
Writing report	28
Reading materials	25
Class presentation	24
Attending seminar	23
Topics of interest (Theme 3)	
Cancer / most	20
.../ reason: real life	14
.../ reason: much information	7
HGP / most	13
.../ reason: real life	7
.../ reason: scientific advances	4
.../ reason: central theme	1
Down syndrome / most	10
.../ reason: real life	5
.../ reason: bioethics	1
Radiation-genetic damage / most	-
Cancer / least	1
HGP / least	3
Down syndrome / least	4
Radiation-genetic damage / least	23
.../ reason: lack of knowledge	9
.../ reason: presentation / ambiguous	12
.../ reason: one-way communication	3
Other issues of concerns (Theme 3)	
AIDS	18
Environmental pollution	15
Human diseases (genetics disorders, malaria, goiter, ...)	10
Applications of biotechnology	10
Bioethics	3
Human health services	2
Main resources to be used (Theme 1)	
Textbooks	23
Lectures	15
Periodicals	14
Handouts	14

Teachers (talking with)	10
Friends (talking with)	6
Radio, television	6
Experts	3
Resources / one kind	4
... / two kinds	15
... / more than two kinds	14

Teacher as facilitator (Theme 1) (15 respondents had no ideas)

Establish classroom environment / positive	11
.../ negative	6
Provide knowledge, preview / enough	14
.../ not enough	5
Provide explanations / enough	9
.../ not enough	2
Encourage students to speak, ask	6
Ask questions / open-ended	10
.../ closed	2

Strengths and weaknesses of class activities (Theme 1)

Classroom environment / fun, interesting	14
.../ undisciplined, sometimes quiet	9
Student participation / active	22
... / passive	10
Peer relationship / good	6
.../ not good	2
Discussion / focusing	18
... / wandering	15
No clear conclusions	6

Outcomes of students (Theme 1, 2, 3)

Knowledge / aware misconceptions	4
Knowledge / enhance	28
Define, analyze issues / clear, logical	6
... / weak	9
Explore diverse points of view	15
Be aware the relevance of science	3
Develop peer relationships	5
Learning from peers	18
Communication skills / positive	15
.../ negative (passive, not talk)	12
Interest of learning	15

Difficulties of students (Theme 1)

Weak communication skills	18
Lack of references	3
Lack of motivation	1
Issues not solved totally	6

Recommendations (Theme 1, 2, 3)	
More discussion / learning activities	22
More explanations	22
More references	9
More relevant issues	3
Monitor learning activities (assign topics/ group, engage all students in learning, ...)	12

Appendix L

Key codes from students' final essay (n=33)

Statement 1: An exposure to mutagens should be restricted in a population to reduce the risks of cancer.

Agree: 33

Reasoning:

facts, statistics	4
scientific knowledge	11
other factors (virus, lifestyle, diet)	4
no reason / vague	13
plan / action	3

Statement 2: We have a right to choose to accept a genetic testing on ourselves or not.

Agree: 33

Reasoning:

personal values	20
scientific knowledge, benefits of genetic testing	8
"patient"'s psychology	7
no reason	6
plan /action	8

Statement 3: Genetics counselors should make all decisions for couples with possible genetic problems in their unborn children.

Agree: 10

Reasoning:

genetic counselors: experts	8
no reason	2

Disagree: 23

Reasoning:

counselor's role: assistant, adviser	16
couple role: responsibility, morality, psychology	21
other factors: social, cultural, moral, etc.	3

<u>Statement 4</u>: An exposure to ionizing radiations increases the incidence of damaging genetic material.

Agree: 33

Reasoning

scientific knowledge	18
no reason / vague	15
plan / action	4

Appendix M

Group interview codes (with students)

Students' interest

- / scientific knowledge
- / real life problems
- / sharing ideas
- / investigating a problem

Students' learning style

- / communication behaviors
- / problem solving skills
- / familiar with lectures

Issue study

- / information resources
  - / experiences
  - / facts, statistics, observations
  - / scientific knowledge
- / question generating
- / points of view
  - / explore, judge
  - / scientific
  - / beliefs, values
- / decision making
- / sharing ideas
- / difficulties
  - / knowledge base
  - / time arrangement
  - / reference shortage
  - / teaching style

Teacher role (from students' expectations)

- / encourage students
- / explain
- / summarize
- / identify solutions

Students' outcomes

- / knowledge
  - / enhancing, verifying
  - / misconceptions
- / communication skills
- / problem solving skills
- / interactions
  - / students-students
  - / students-teacher
- / interest of
  - / science
  - / social issues