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Attitudes of Japanese Students in Relation to School Biology

by

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Abstract

This study explores attitudes in biology classes of Japanese junior high school and high school students and also asks them to reflect back on their school experiences. In Japan, the educational environment for students is very good: for example, many students can have opportunities to go to school and the majority of schools have enough facilities for science classes. However, many students think biology is difficult and there are doubts whether students can use biological knowledge to their advantage in life after graduating from school.

It is argued that the aim of teaching biology is in making educated students: people who can understand the importance of the role of biology in their society and can make judgements or decisions based on biological views, where appropriate. For these reasons, it is very important to not only give biological knowledge but also to encourage the development of positive attitudes towards biology in biology classes.

This study discusses definitions of attitude and is based on one approach in the literature. It would be helpful to understand what causes students attitudes to develop and why students behave positively/negatively in biology classes. It might be possible to encourage more positive student attitudes. In Japan, there is a strong tendency to focus on memorisation. This often fails to connect biology classes with the students' real life.

This survey was carried out with two different groups: Shotoku gakuen High School and Meiji daigaku huzoku nakano hachioji High School (total is 1270 students) using a questionnaire. The aim was explore students current attitudes in biology classes comparing different grades and different genders. In this way, it seeks to consider how attitudes are changing with age as well as the aspects of their learning which affect boys and girls differently. The chi-square statistic was used to evaluate differences between various groups.

In general, attitudes became less positive with age. As with previous studies in physics, all students were found to show preferences for studying topics and themes which they can connect to previous knowledge and experience and which make sense in the context of their lifestyles.

Boys and girls in most areas hold very similar attitudes but boys tend to be more interested in the topics which relate more to the world outside of them: for instance, the role of biology for society. Girls, on the other hand, tend to prefer topics which are more personal and relate to human interaction: for instance, the human body and how it works. This suggests that great care must be taken in curriculum construction, textbook writing and lesson presentation so that boys and girls are attracted equally.

The study presents an exploratory overview of the situation in a range of schools in Japan. It is based on established psychological models relating to learning and attitude development. The study offers proposals for future work and implications for future teaching in Japan.

Acknowledgements

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Chapter 1

Biology in Japanese Schools

1.1 Introduction

Biology holds a place in the curricula of schools in most countries at secondary stages (age 12 and over), often with high numbers of students involved. Nitobe (1988) considers the role of the teacher in the context of Japan:

> '*When character and not intelligence, when the soul and not the head, is chosen by a teacher for the material to work upon and to develop, his vocation partakes of a sacred character. "It is the parent who has borne me; it is the teacher who makes me man."*' (quoting Confucius). (Nitobe, 1988, pages 203-4)

In this way, Nitobe suggests that there are deeper aspects of education which go well beyond the development of intellect and these are vitally important.

However, in Japan, there are changes in curriculum emphasis which have been applied to schools by successive governments. One of these can be translated as: '*less strenuous education'*. There is concern in Japan about the declining place of science and that some students do not appreciate how biology contributes to our world and do not appreciate how important it is to have biological knowledge through biology classes. Therefore, teachers need to know what attitude exactly students have in a biology class, why students acted and how to develop it when they teach biology.

1.2 Attitudes in Relation to Biology

According to Jung (2005), science teachers do not teach students science seeking to make the scientists of the future but the aim is to produce educated students, "*who can make sense of life and themselves; can appreciate the place and role of science in modern society; can relate their studies to culture, lifestyle and social importance."* However, many students think science (biology) is difficult and seem to have an increasingly negative view for it year by year. There is a concern that students might be gaining knowledge from biology classes but are unable to relate the knowledge to themselves or to real life.

> '*As the details of scientific formulae fall away in the months and years after school, it seems likely that the crucial deposits of science and technology education are to do with attitudes approaches and even values.*' (King, 1989)

Thus, to develop student attitudes is incredibly important because impressions of school science persist much longer than memorised knowledge like, for example, Newton's Law, the formula for sodium chloride or the characteristics of living things. (Jung, 2005 referring to Jonathan *et al*., 1998).

Students need to know and use biological knowledge for life in a high technology society. For instance, for appreciating present technical revolution, for judging and deciding biological issues (e.g. genetic manipulation and environmental pollution) and make sense of students' life (Jung, 2005).

The problem is that, while it is relatively easy to define the content to be memorised for later recall in examinations, it is not so easy to describe the attitudes relating to biology which are likely to be important. Indeed, the definition of attitude itself is not easy. This study will bring together the findings from social psychology and offer a working description of attitudes and will seek to base the measurements on that description.

1.3 Aims of This Study

This study is set against the context of great concern about *less strenuous education* and its effect for current biology classes as well as the importance of producing students from school whose attitudes towards biology, its place in society and the impact of its development on the important issues for Japanese society.

The main aim in this study is to gain an overview of what is happening in Japan with school students from ages 14-18 in their attitudes related to science, to see how these change with age as they move up their schools and to see the ways in which boys and girls differ in their views and interests. It is hoped that the outcomes of this survey will offer direction for action and for further studies.

1.4 How the Work was Conducted

This thesis will start by considering the place of biology in the school curriculum and its development. There is discussion about why students should study biology, all considered in the context of the Japanese educational system for biology classes. This leads on to a review of the literature relating to attitudes, their definition and their development while chapter 4 considers the very difficult question about attitudes can be measured to offer valid and reliable pictures of the perspectives of the student population. It is argued that traditional scaling methods are inappropriate and make unwarranted assumptions while it is accepted that, with current approaches, attitudes of individuals cannot be measured with any degree of accuracy.

The next two chapters describe the attitude survey which was devised and used with over 1000 Japanese students from four age groups. The data are analysed to see how each perspective has changed with age and these changes are interpreted as far as is possible, taking into account the way the Japanese education systems operates. The responses of boys and girls are then compared to see how they differ. This is important in that, in Japan, as in most countries the gender balance is far from equal, with girls outnumbering boys in elective biology courses at school and university.

The final chapter offers an overview of the whole thesis and reflects on the work critically. Some implications from the findings are drawn and, based on the results, some future work is suggested.

Chapter 2

Biology and the School Curriculum

2.1 Biology Education as Part of Education

The nature and purpose of a school curriculum is a highly complex area. The tendency is for teachers of specific subjects to see the value of their own subject specialisms but be unable to see these in the wider context of the whole curriculum or the social context of society (Alhmali, 2007). Whitfield (1971) in discussing the work of Hirst (1965) stated that '*A liberal education can only be planned if distinctions in forms of knowledge are clearly understood*'. The idea of '*forms of knowledge*' was derived from the work of many educational philosophers including Hirst (1965, 1969) and Phenix (1964). They held the view that there were different types of thinking and, later, Whitfield attempted to translate this into a secondary school (ages 12-18) curriculum. The work of Whitfield made a considerable impact in thinking in Scotland (Munn Report, 1977).

Earlier, Snow (1959) in his famous essay entitled 'The Two Cultures' saw knowledge in two domains: arts and science. He argued that the science domain was far more useful in that those trained in it could make sense of the arts domain while the converse was not true. He even made the remarkable statement that all school students should understand the second law of thermodynamics. As this law summarises the key factors which drive change, his argument has some substance in that change is the one feature that everyone faces throughout life. It is interesting to note that this did appear in one Scottish school syllabus: the Chemistry Certificate of Sixth Year Studies (CSYS, 1969) and was found to be accessible to these students. However, this course was only taken by around 1500 students each year.

Nonetheless, the argument of Snow (1959) suggests an important idea: the curriculum should be designed around the needs of the students in their attempt to make sense of the world around, the word 'world' being interpreted in the widest sense. This idea was picked up much later by Reid (1999, 2000) when he argued for an applications-led curriculum in all the sciences.

Whitfield (1971) developed a curriculum model based on seven groups of concepts: seven ways of thinking. He then attempted to allocate the school subjects of his day in England to these seven ways of thinking. This was a very cognitive analysis.

Table 2.1 shows his seven categories and how they related to the previous work of Hirst (1965) and Phenix (1964). Phenix had suggested six categories and he argued that, '*Without these, a person cannot realise his essential humanness. If any one of the six is missing, the person lacks a basic ingredient of experience*.' This assertion led Whitfield (1971) to argue that every student at secondary stages should take courses which which, together, would offer experiences in all seven categories. This is still the basic model underpinning the Scottish curriculum at all stages (see '5-14', 2000).

Phenix's 'Realms'	Hirst's 'Forms'	Meaning of Category	School Disciplines
Symbolics	Mathematics and logic	Communication- the necessary means of expressing all meaning	Ordinary language, logic, mathematics, symbols in expressive arts
Empirics	Physical science	Truths framed upon the experimentally verified conceptual system	Physical, life and social sciences including psychology
Aestetics	Literature and fine arts	Contemplative perception and idealized subjectivities	Literature, music, visual, and movement arts
Synnoetics	History and the human sciences	Interpersonal relationships	Parts of literature, philosophy, history, psychology, and theology
Ethics/ morals	Morals Philosophy	Obligation to codes, freely and responsibly selected	Parts of philosophy and theology
Synoptics	Religion Philosophy	Integrated selfhood	Philosophy, religion, history

Table 2.1 Categories of Knowledge

The model suggested by Whitfield (1971) offered some kind of rationale for the school curriculum. However, it was set in terms of ways of knowing. Whitfield seemed to acknowledge that the basis was inadequate in that the model ignored students interests and personalities. Indeed, it assumes that education is set strictly in the cognitive and ways by which knowledge is developed and known. There is a neglect of skills and attitudes while the model undervalues human individuality and the needs of wider society (see Reid, 1999, 2000).

With regard to the sciences, Whitfield (1971) argued that students should continue to show the abilities (a) to (h) below and these abilities should be developed during their courses:

"(a) discriminate between problems to which a scientific approach is appropriate and those to which it is not;
(b) recall information and experience;
(c) devise schemes for solving practical scientific problems;
(d) use and classify given information;
(e) apply previous knowledge to new situations;
(f) interpret information with evidence of judgement and assessment;
(g) report and comment selectively and effectively;
(h) relate science to other school subjects and life in society."

Whitfield (1971) states that these abilities do not develop automatically and students need to progress through education so that they can develop.

There are three factors which must be considered: what is to be known; school subjects; student abilities.

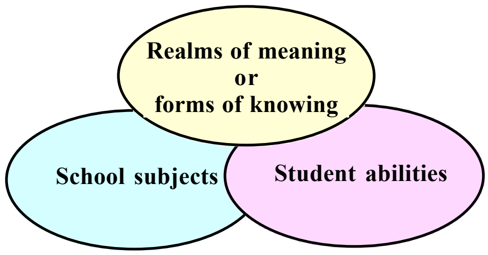


Figure 2.1 Three Interrelated Factors

In looking at the way the curriculum is to be constructed, there are several fundamental questions:

(a) Are the realms of knowledge or ways of knowing taking in all that is needed to educate a student completely?
(b) Can school subjects be related meaningfully to these realms of knowledge or ways of knowing?
(c) What are the needs and aspirations of students which have to be met through education?
(d) Do all students need to 'cover' all the realms of knowing or should there be allowance for interest and abilities?

Clearly, the answer to (a) has to be ‘no’ in that the analysis of Whitfield ignores major aspects of life development. For example, the Scottish curriculum added another area (technology) to its curriculum structure (see: ‘5-14’, 2000). However, this still leaves major gaps. There is no emphasis on skills which are primarily cognitive and there is no mention of attitudes. The answer to (b) is also ‘no’. A quick analysis of the ways subjects are allocated in the Scottish curriculum (see: ‘5-14’, 2000) leaves major doubt. Thus, subjects like Home Economics, Computing Studies, and Craft and Design are all considered as ‘technology’ subjects, implying some kind of equivalence. This is obvious nonsense. Equally, it is assumed that a student taking a course in any one science satisfies the science domain. This is also an inadequate conclusion: the methods of, say, physics are very different to those of biology which is far more descriptive and also dependent on conclusions based on statistical evidence.

The real and more fundamental problem is that the Whitfield (1971) approach tends to reduce education to the satisfaction of a range of cognitive processes, ignoring the powerful interrelationships between attitudes and learning as well as neglecting abilities, motivations, emotions and skills. Students who are not interested in academic subjects tend to reject such educational experiences and disaffected young people can be produced.

A better approach might be to analyse the needs and aspirations of the students at their stage of life to see what the school can offer which will meet their needs. These can be seen in terms of their understanding of the world around, their needs for skills and knowledge for the workplace, their preparation as citizens and, probably, parents, as well as giving them the wide range of skills so that they contribute constructively to their society as well as derive the benefits available through their society.

Against that background, it is now worth considering the role and place of biology in the school curriculum. What can biology offer that is unique to itself and is meaningful in terms of the criteria above.

2.2 History of Biology Education

Slingsby (2007) notes that the first person to emphasise biology in the curriculum was T. H. Huxley, an English biologist, in 1875. This curriculum was constructed including two concepts, which are *plant and animal 'types'*, and *systemics and natural selection*. He designed this course as 'Biology' rather than 'Natural History' and it developed not only in the England but also in many other countries. Huxley expected his biology curriculum would connect biochemistry, genetics. microbiology and ecology which were all emerging at that time.

In the Scottish context, Biology remained as a subject of minority interest until the early 1960s. The course tended to be descriptive and was often offered only to those of moderate ability, courses in physics and chemistry being seen as having higher status. The early years of the 1960s saw radical new syllabuses in chemistry (Curriculum paper 512, 1962) and physics (Curriculum paper 490) and this was followed by a new biology syllabus (Biology at Ordinary Grade, 1966). The three sciences were separated from each other and were overtly given equal status for the first time. All three syllabuses laid great emphasis on understanding and, indeed, the topics studied and the way of studying was exciting and refreshing. They certainly proved popular.

In the 1970's, there was a reversion to science and biology became confused with chemistry and physics (see Curriculum Paper 7, 1967). A simple comparison between the composite course (science) and the syllabuses of the three separate subjects shows how much was lost, both in terms of content coverage and intellectual rigour. Science was approached simply and generally. Much of the reason for this trivialisation of the sciences lay in the fact that a teacher qualified in one science discipline was now expected to teach all three. Given the explosion in scientific knowledge and understanding, this was asking the impossible. The pressure to integrate grew and, although schools resisted, by the late 1970s, integration of the sciences to age 14 was almost complete in Scotland. The integrated syllabus was closer to an amalgamation of some parts of biology, chemistry and biology, taught by one teacher. The separate topics of the three disciplines were still evident, the integration being largely organisational in the way the course was taught.

Of course, the biology curriculum has developed much since then. However, the underlying philosophy has been inadequate: thus, Slingsby (2007) considers it is time to re-think the biology curriculum for the 21st century. One of the outcomes of the equal status accorded to biology in Scotland in the 1960s, was the incredible growth in uptakes. This can be seen in figure 2.2 which shows the way entries at the Higher Grade (for entry to university) have grown.

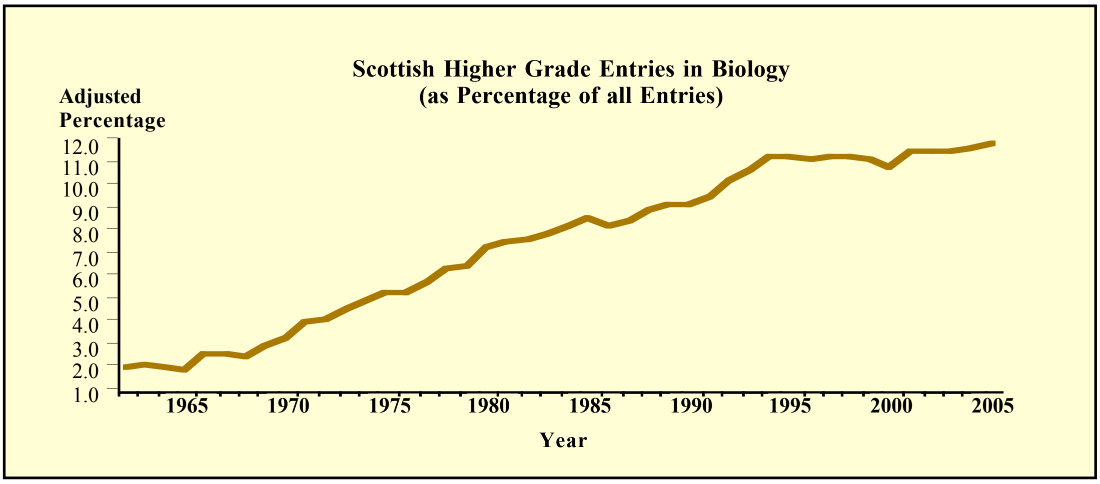


Figure 2.2 Growth in Biology in Scotland

The growth in Biology in Scotland gave it roughly equal numbers by the late 1980s and the growth has continued since then although there are signs that it might be reaching its limit today. The growth can be compared to that of the other two sciences (figure 2.3)

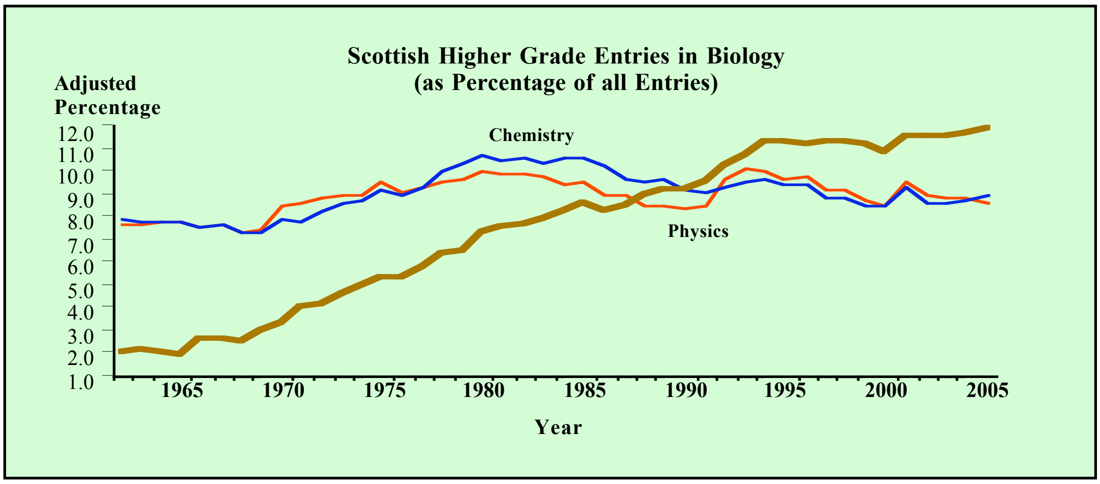


Figure 2.3 Growth in the Sciences in Scotland

In Japan, from 1990 to 2000, students who entered the National Centre Test in Biology was steady at around 30%. Then there was growth from 2000 to 2005 when it reached around 35%. Physics has about 32%, slightly decreasing from 1990 to the present time. Chemistry has been the most popular subject for the National Centre Test, varying between 35% and 42%. The growth of biology can be compared to that of the other two sciences (figure 2.4).

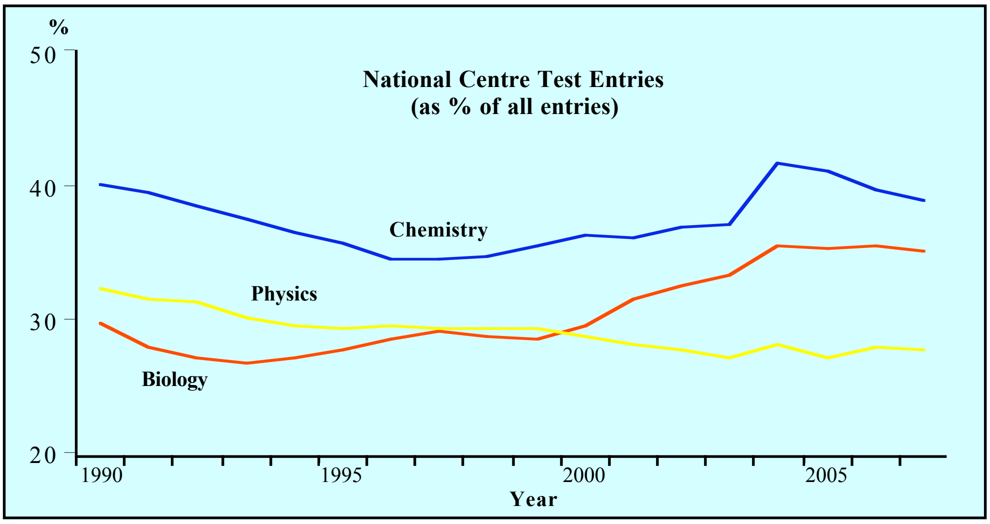


Figure 2.4 The Sciences in Japan

2.3 Why Study Biology at School?

Although the justification for biology in the Scottish school curriculum rested mainly with its status as a science and thus its supposed ability to educate the students in thinking 'scientifically', biology has an obvious place in any school curriculum for all students. Rowland (2007) argues that the biology curriculum should attract students' interests, help students to understand themselves and the way their bodies work as well as assist them in making ethical life choices. Biology has implications for health, social issues and student careers (Rowland, 2007).

It is a very important thing for all to have healthy life for everybody and biological knowledge can assist: understanding the routes of infection, the immune system, how people 'practise good domestic hygiene' and 'use ordinary medicine such as antibiotics' (Rowland, 2007). People sometimes do unhealthy things because of lack of knowledge: for example, malnutrition because of diet and superstitions such as 'Cold heals when it moves to other people'. Moreover, students who come from developed countries such as Japan learn about micro-organisms in the context of a clean environment surrounding them, providing clean food, water and air to give good health.

There are other problems, some them self-inflicted: HIV, infectious disease from drugs, young age abortion, alcohol abuse and falling into depression. These issues confront students' throughout their lives. According to the Tokyo metropolitan government (2004), the percentage of high school girls who have had sexual experience in Tokyo has increased from 17.1% in 1990 to 45.6% in 2002 and, consequently, notified sexually transmitted diseases are 1.9 times more than five years before; the number of abortion cases in Japan are 1.4 times more in the last ten years (from 29,776 in 1993 to 40,475 in 2003).

Furthermore, there are serious environmental problems which people cause such as pollution, global warming and decreasing natural resources. For instance, according to The Tokyo Electric Power Company (2003), Japan relies on nuclear power to make 23.1% of its energy and there are 13 nuclear power plants in operation in Japan. It is very useful to produce large amounts of energy at low cost but, on the other hand, there are dangers from deterioration or earthquakes. An accident might cause a considerable amount of damage for the human body and the environment. Therefore, students need to know the benefits and risks before nuclear plants are build in terms of the effects on human tissue.

Some topics in the biology class are difficult for students to connect with their lives directly because their effects are complex and indirect: for instance embryology, physiology, taxonomy, anatomy and genetics. However, these issue are extremely important for us to know. Indeed, it could be argued that a mature grasp of the basics of genetics is an essential for every young person, given the medical and social changes arising from ongoing research.

Rowland (2007) states that, '*Life is a self-replicating, self-regulating system built out of material from the earth and driven by energy from outside and inside the Earth*'. Biological explanations can offer key insights into the mechanisms of the human body in the context of the environment. The whole nature of meaning of the concept of evolution is also very important. Humans need to see how plants and animals exist and develop and the whole issue of the extinct species and the way this can happen as well as understanding some of the consequences is important for everyone.

Biotechnology has developed enormous importance, with consequences for agriculture, pharmacy, medical science, odontology, veterinary medicine and engineering. There are many possibilities for genetic manipulation. It is important to know what kind of things we can make using biotechnological techniques today and to think whether it is right or wrong. Biology classes could help students to give opportunity to consider past developments, consider the future and prepare for the ethical choices which will face everyone.

Even in this brief discussion, it can be seen that knowledge derived from biology has a major significance for the lives of all students and for the way societies may develop. This offers some justification for the argument that biology should be taught to everyone. It can enable the students to understand themselves, their world and equip them to make a useful contribution to society and understand the implications of decisions for the future.

2.4 Difficulties in Biology

Bahar *et al*. (1999) explored the areas of difficulty in biology. They surveyed 207 first-year university students who studied biology at school. They considered 36 topics from the published syllabuses of the Scottish Examination Board at Standard Grade (about English GCSE level) and at Higher Grade (university entrance level) and then asked students to rate each topic in the following way:

Easy	Understood without any difficulty
Moderate	Found it difficult but understand now
Difficult	Still do not understand
Did not study the topic	

Six topics appeared as ‘difficult’ topics where over 10% of the students chose them. They calculated an index of difficulty:

$$\text{Index of difficulty} = \frac{\text{(Number of students who said it was difficult)}}{\text{(Number of students who had studied the topic)}} \times 100\ \%$$

Five of the six topics with indices of difficulty above 10 are related to genetics (see table 2.2). Teachers with more than five years experience were also consulted. While there was some indication of similarities, there were also some differences in their views. The findings of Bahar *et al*. (1999) followed earlier work by Johnstone and Mahmoud (1980a, 1980b) and showed considerable consistency.

Topic	Difficulty index (%)
Monohybrid and dihybrid crosses and linkages	22.2
Genetic engineering	13.4
Genetic contorol of development and metabolic processes	13.3
Meitosis and meiosis	11.9
Central nervous system, sense organs and co-ordination	10.8
Gametes, alleles and genes	10.4

Table 2.2 Difficult Topics in Biology

In a major study in chemistry, Sirhan (2000) surveyed student views of topics difficulty in chemistry and then compared these carefully to examination performance by looking in detail at hundreds of examination scripts. He found that the students had picked out remarkably accurately the topics where they were having genuine difficulties. Thus, the student perceptions seem accurate, an issue addressed by Bahar *et al*. (1999). Bahar *et al*. (1999) then went on to explore the reasons why students found these six topics difficult. Following a series of interviews, they found three main reasons: complex language, mathematical aspects, amount of discussion. Their findings are now summarised briefly.

Language problem: Genetics has much terminology and complex vocabulary. Some words are quite similar: for example, homologue and homologos, homozyhos. Furthermore, sometimes teachers have to teach similar words which have different meaning at the same time: for example, meiosis and mitosis. That cause students more confusions. Therefore, students have not only to remember the precise meanings of words but also to try to grasp the underlying meaning of ideas, at the same time.

Mathematical content: Much symbolism is used and much is easy to confuse. There is also the problem that mathematical ideas (like probability) underlie much genetics. Again, the student is trying to hold the ideas relating to probability at the same time as trying to grasp the genetics concepts

These two factors are the main problems but students do not always think of genetics negatively. Some of student comments are: '*At the beginning I found genetics more difficult than other biology topics and I did not like it,,, but when I began to understand it, I realised it was interesting and I began to enjoy it*', '*I like genetics, but I could not understand it easily and it was disappointing*'. Furthermore, some students and teachers argue that there is little discussion time to understand genetics and consider each meaning. The students seem to need time to 'play with ideas' and to explore principles and concepts.

Much of this simply relates to information overload when students are being asked to hold too many ideas at the same time.

2.5 Information Overload

After many years of data gathering in looking at topics where learners found difficulties, Johnstone began to appreciate that the difficulties were being caused by information overload (Johnstone and Kellett, 1980). Many year before, Miller (1956) had found a way to measure the capacity of what he called the short term memory and he found that the number of pieces of information which people can hold is 7 ± 2. The majority can hold 7 items (or 'chunks' as Miller described them) while a few can hold 1 or 2 more or less. The capacity could not be altered and, when people have too much information at the same time, they cannot deal with all of the chunks and can handle only few things which they can hold. Later, it was appreciated that the space which Miller called short term memory was perhaps better called working memory in that, while it is the space for remembering something for a short time, it is also the space where information is processed, understood or, indeed, where problems are solved.

It is shown by Johnstone *et al.* (1998) that, from all the information which comes at a person, there is a selection of what is seen as important, this being done consciously or unconsciously. Previous work by Ausubel et al. (1968) had shown that the selection was controlled by previous knowledge and experience. As Johnstone et al (1998) stated, the perception filter is driven 'by criteria which are already available in the mind of the expert, his previous knowledge, interests, misconceptions'.

The learner at early stages does not have enough knowledge to make selections easily and can easily take in too much information. In a similar way, previous knowledge and experience allows a learner to group items of information together and the working memory can, therefore, see several pieces of information is simply one chunk. This process was described as 'chunking' by Miller (1956). All of these findings can be brought together in a model which seeks to offer a general description of the whole learning process (Figure 2.5).

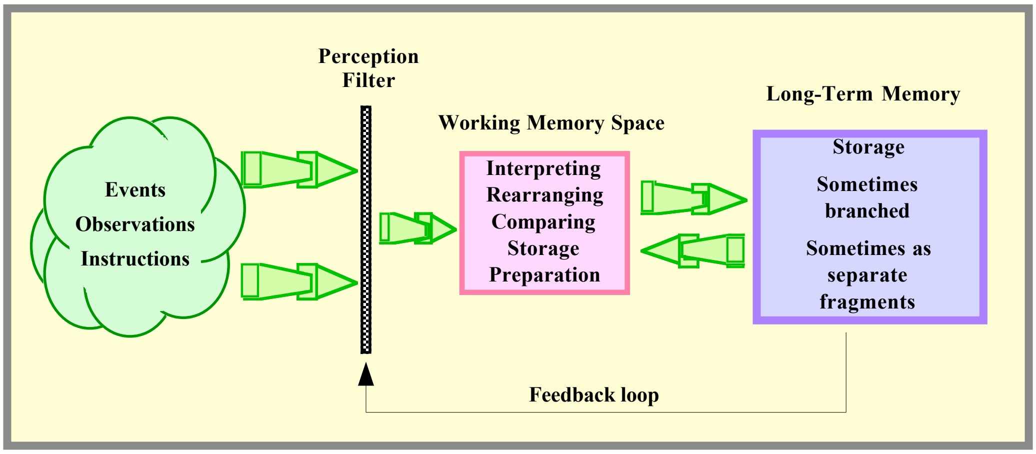


Figure 2.5 Information Prcoessing

Johnstone and Elbanna (1989) studied the limitations of working memory. With a sample of 22,000 sixteen years olds, they related average performance to the number of pieces of information required to solve each of a series of questions. Figure 2.6 shows the way student success related with a series of questions of increasing complexity until, at a certain point, most students fail. The number of questions which students could solve dramatically decrease when students are required to hold approaching seven pieces of information.

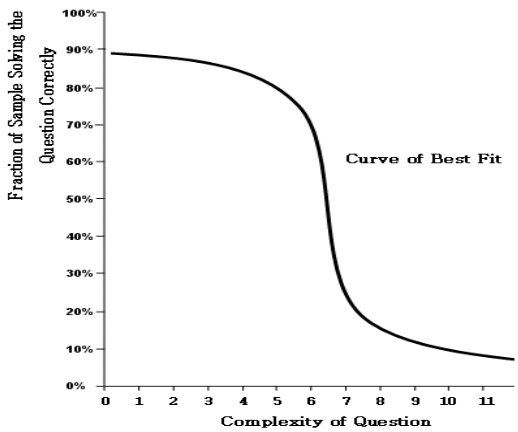


Figure 2.6 Curve of Best Fit (From Johnstone and Elbanna, 1989)

(Students have success with a series of questions of increasing complexity until a certain point, after which most students fail)

Johnstone and Elbanna (1989) took another sample and divided students into three groups where students could hold five, six or seven pieces information at once and did a similar experiment. The result is shown figure 2.6. This showed very clearly that it was the working memory capacity which was the main determining factor which influenced the success of students.

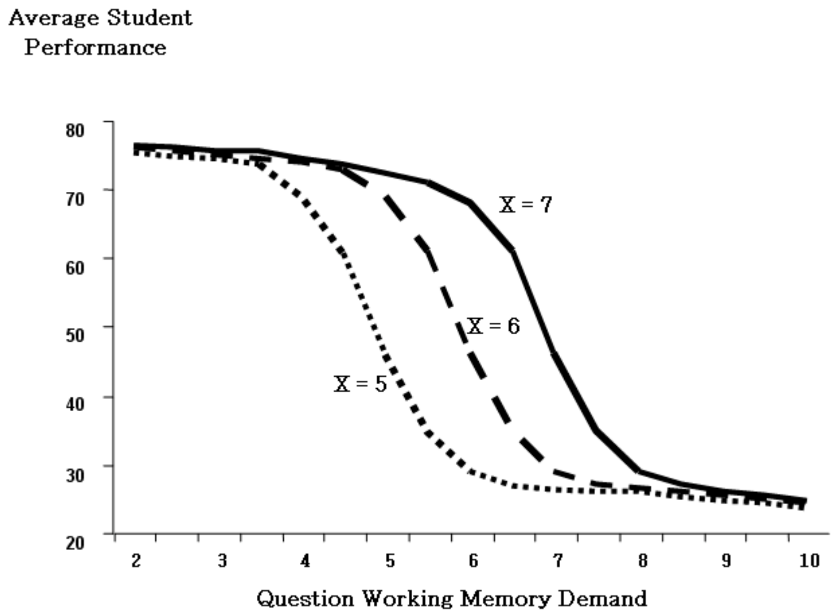


Figure 2.7 The Performance of Students in Questions of Different Demand
(Developed from Johnstone and Elbanna, 1986)
(Showing the division of the group into high, medium and low working memory capacities)

Information may be passed from the working memory to the long term memory for storage. There seems to be no limitation in storage capacity and information can be held eternally Solso, 1995). Long term memory is very important because it connects perception filter and working memory strongly. It might provide new criteria when people have inconsonant information and change the process of selection. (Driver *et al*, 1985).

According to Johnstone *et al.* (1998), there are two kinds of storage: *rote learning* and *meaningful learning*. With rote learning, information is stored in a form where it is not connected with previous knowledge while, in meaningful learning, "*new information is attached to existing learning, making it richer, more interconnected and accessible through many cross references*" (Johnstone *et al.*, 1998). These two look similar but Entwistle (1983) argued there is part of the differences between what he called *deep learning* and *shallow learning*. Therefore, time needs to be given for thought and discussion so that ideas can be processing, grouped, understood, in order to lead to deep learning.

Thinking primarily of chemistry, Johnstone (1991) appreciated that there were three levels of thought which were often needed (Figure 2.8).

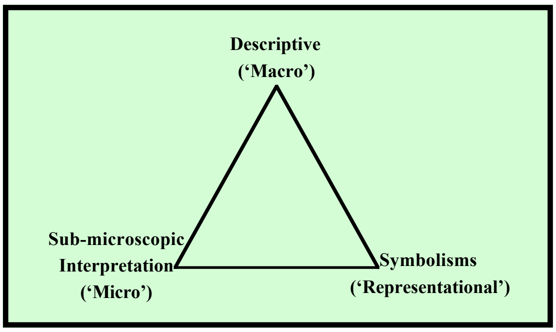


Figure 2.8 Three Levels of Thought

The macro can be observed directly: plants and animals can be seen and touched. There are several levels of the submicro: genes and alleles as well as molecular situations. Symbolic things are often represented thorough symbols or mathematical ideas and seek to offer some kind of mental model of reality. The problem is that, when a student is faced with all three levels at the same time, there is almost certainly going to be information overload.

Bahar *et al.* (1999) suggest a solution based on the idea that teachers should introduce students to the three levels step by step. This is based on the ideas of Johnstone (1991) who described the process as:

> "*... thinking slowly, coming back to it many times and controlling the complexity by operating on the sides of the triangle only. This will need time to develop experimental experience of the MACRO, careful control of vocabulary and concepts in the SUBMICRO and phased introduction of the SYMBOLISM*".

2.6 Teaching Styles in Japan

After World War II, there was the start of a period of sustained high-level economic growth (from 1955 to 1975) in Japan. At that time, it was felt that Japanese society needed elite groups, those with high academic backgrounds who might carry forward the leadership of this growth. This brought about a kind of education where as much information as possible was compressed into the teaching time available, the aim being to pass entrance examinations for good universities. The problem of this kind of education is that people can obtain high grades in examinations but they rapidly forget much after the examination. It discourages the ability of invention, creativity, independent and critical thought. Thus, people lost the reasons why they study or learn something. People started to feel that studying at school is useless for Japanese society because some students, achieving high grades, could not cope with people. Moreover, students were under high pressure when they think about entrance examination and it was considered that this was disturbing students' healthy intellectual and emotional growth.

In 1960s, the troubles in Vietnam led to very large exports from Japan and this contributed to Japan achieving the second place as a capitalist nation in 1968 in terms of its Gross National Product. Therefore, Japanese society has had years of plenty. This situation makes it difficult to continue with a standardised highly structured form of educational system. Children needed the opportunity to choose their future jobs. They need to have some choice in their schooling experiences. They needed not only knowledge but the ability to be able to solve problems.

Thus, after 1977, Japanese government started to reconsider its policy of education. This happened three times and they described the new educational style called '*less strenuous education'*. The Japanese government would like all adults and children to develop the skills for living. This was seen as having three elements: high levels of knowledge and understanding; personal and social development enabling students to function well in society; healthy physical development (Ministry of Education, Culture, Sports, Science and Technology, 2007). The features of the new policy of education are that the number of classes has decreased (see Table 2.3, Hyoudo, 2002), the contents of textbooks have declined and a new subject called General Subject (*Sougouteki na jikan*) has been established in Japanese public schools.

In Japanese schools, one class lasts for 50 minutes and basically one credit requires 35 classes. (except correspondence course). Teachers teach biology (or science) along the authorised textbook. Therefore, it is possible that some students do not take a pure biology class at all during their high school time (ages 15-18). For example, a student could take general science and chemistry and this situation depends on his/ her high school curriculum. Table 2.3 illustrates the develop over time.

Year of notify **Year of operation**	**1960** **1963**	**1970** **1973**	**1978** **1982**	**1989** **1994**	**1999** **2003**
Compulsory subject	4 subject (A or B) and overall more than 12 credits	Basic Science or two subjects and overall 6 credit	Science I and overall 4 credits	two subjects from different section	Basic Science or one of General Science A, B. overall more than four credits
Research year	1970	1980	1990	2000	next term
Number of high school students/3	1,410,000 100 %	1,540,000 100%	1,880,000 100 %	1,420,000 100 %	
Physics () is number of credits	Physics A(3) 55 % Physics B(5) 38 %	Physics I(3)82 % Physics II(3)15 %	Physics(4) 34 %	Physics IA(2)18 % Physics IB(4)30 % Physics II(2)13 %	Physics I(3) Physics II(3)
Chemistry () is number of credits	Chemistry A(3)55 % Chemistry B(5)47 %	Chemistry I(3) 100 % Chemistry II(3)23 %	Chemistry(4)56 %	Chemistry IA(2)35% Chemistry IB(4) 69 % Chemistry II(2)19 %	Chemistry I(3) Chemistry II(3)
Biology () is number of credits	Biology(4) 82 %	Biology I(3)86 % Biology II(3)16 %	Biology(4)	Biology IA(2)26 % Biology IB(4)64 % Biology II(2)15 %	Biology I(3) Biology II(3)
Geology () is number of credits	Geology(2) 60 %	Geology I(3)38 % Geology II(3)2 %	Geology(4)11 %	Geology IA(2)9 % Geology IB(4)10 % Geology II(2)1 %	Geology I(3) Geology II(3)
General Science () is number of credits		Basic Science(6) 4 %	Science I(4)100 % Science II(2)3 %	General Science(4) 4 %	Basic Science(2) General Science A(2) General Science B(2)
Note	have to either Physics A, B or Chemistry A, B	II can be learnt after I	Science I is compulsory subject	II can be learnt after IB	II can be learnt after I

Table 2.3 Changes in Government Guidelines for Teaching

In general, the *less strenuous education* is thought to be the cause of a decline of scholastic ability. However, this conclusion depends on what is meant by scholastic ability. If ability is measured by performance in examinations and tests which essentially measure the recall or recognition of information, ideas and skills, then there might be a decline. The difficulty is that it is much more difficult to measure the other outcomes: skills like critical thought, creativity, conceptual understanding, problem solving abilities. The development of education in the sciences has to be seen in the context of this rapid change in educational understandings and goals.

There is an argument whether Japanese students are less interested in the sciences compared with before and if their understanding has decreased in science classes and if the number of people who do not have basic knowledge has increased because of '*less strenuous education'*.

It has been argued that supposed declining standards is caused by the reduction in the time allocated to the sciences. According to Takigawa (2004), the number of hours of science classes a year has decreased. In 1969, it was 1048 hours per year, in 1977 it was 908 hours and in 1989 it was 735 hours. Then, the latest revision of 2002 gave 640 hours.

Table 2.4 shows a rough comparison between what happens in Japanese schools (Takigawa, 2003) and Scottish schools although it has to be recognised that, in Scotland, the actual time allocated between ages 5 to 11 may be much less.

Age	5	6	7	8	9	10	11	12	13	14	15		Totals
	Hours per Year												
Japan	-	-	-	70	90	95	95	105	105	80	80	*one subject*	720
											160	*two subjects*	800
Scotland	47	47	47	47	47	47	47	104	104	104	104	*one subject*	745
	School often give much less time than this to the science area									208	208	*two subjects*	953
										312	312	*three subjects*	1161

Table 2.4 Japanese and Scotland's number of school hours for science classes

While the time allocated in Japan seems less, it is not that different from that operating in Scotland. However, the percentage of school hours given to science in junior high schools in Japan (9.8%) is low for advanced nations in 2002. England is quoted at 14%, the Czech Republic is 21%, Hungary is 13%, France is 12% and South Korea is 11% (Japanese Science Association, 2004 in referring to Takigawa, 2004). However, these are quoted figures and may or may not match reality.

The Japanese government considers that General Subject (*Sougouteki na jikan*) is able to cover declined school hours of science classes and it has 105-210 classes (depends on schools) until students graduate. (Ministry of Education, Culture, Sports, Science and Technology, 2005). However, the General Subject is a very flexible subject because each school is able to choose what they would do in classes at this time and it used not only for the sciences but also for other subjects. Some schools do not use this time for the sciences at all. Therefore, it cannot be said that General Subject fills in science classes.

The time issue may be important but it is not easy to demonstrate. What can be said with certainty is that the time devoted to the sciences in Japan has declined with the years. This is one inevitable outcome of integrating the teaching of the sciences. For example, in Scotland, the time allocated per week at ages 12-14 was 240 minutes in the early 1960s in Scotland when biology, chemistry and physics were taught separately (Reid, 2007). As soon as integration came in, school administrators saw the subject as one and, in a situation where time was precious, reduced the allocation steadily until, now, the time allocation is about 160 minutes ('5-14', 2000). Time is important but what is to be taught and how it is to be taught may be more important.

In Japan, new government guidelines for teaching have approximately 70% of the contents of the previous one (Ministry of Education, Culture, Sports, Science and Technology, undated). With the previous course of study, there was the upper limit of contents which should have been learnt but it became the lower limit from 2002. Many Japanese students have the view that they should only cover the textbook contents. Therefore, there is a tendency which students do not want to study above the contents of textbook or they want to learn within the range of the contents of regular examinations.

In Scotland, teachers supply textbooks or similar material but they rarely use them in the science class and students usually do not need to bring them to the class. They use such material as reference and, therefore, students are able to look at things which they want to know from these materials. In addition, these resources are often not limited to the strict syllabus contents. This kind of material is welcomed by very few Japanese students.

With the rigid curriculum and time pressures, there is often not enough time to do experimental work in science classes under the new policy in Japan (Takigawa, 2004) because teachers have to cover all the contents of authorised textbooks and it takes time for that. In Japan, it is very common that experimental work is teacher demonstration or following a laboratory manual. Of course, it depends on how a science teacher would like to teach but these approaches are adopted to save time. Takigawa (2004) argued that it is very important for school students to acquire not only new scientific knowledge but also scientific thinking skills (he called these 'research ability'). He saw this as considering problems, trying to find how to solve them, devising appropriate experiments and exploring the results. However in current government guideline for teaching, it could be said that there is not enough time for not only experimental work but also time to think and ponder about what students learn through their science classes. Whitfield (1971) quotes Hirst (1969) about curriculum when he said,

> *"It is all too easy, with the best intention in the world, to cease to teach the subject to the less able in any significant sense at all. By not really bothering whether or not they have got hold of the concepts and can use them, by being content with memorised statements, by allowing pure repetition of operations, by omitting anything which demands even the briefest unrehearsed argument or justification, we simply evade all the problems and totally fail to develop any significant understanding. However we accommodate ourselves to the less able, it must not be by losing the essential concepts, by losing genuine operations with them, by being uncritical of invalid reasoning and so on."*

In Scotland, there is much experimental work in science classes (Johnstone and Wood, 1977) and, in some courses, students have to complete prescribed experimental work. At the Advanced Higher Grade, each student has to find what they would like to research, deliberate it and report it, the work being graded as part of the final mark. There are opportunities to have experimental work in Japanese science classes but there is no responsibility to do it actively. Therefore, in comparison of Scotland, there is less opportunity to consider deeply and individually in Japanese schools. Scotland has always had a tradition of experimental work (Johnstone and Wood, 1977) and it is accepted a main component of all science courses.

In the west, experimental work was established in 1824 at university level and, in 1899, it has been available in secondary school as well in some countries. At that time, practical work was applied to show that the theory which students learned was correct. (Morrel, 1969, 1972). There was some opinion that doing individual experimental work directly is better than doing demonstration experiments (Hodson, 1990). In 1987, Letton (1987) observed that '*real interest in chemistry developed the habit of doing their experiments mechanically to get the result expected rather than to observe what is actually going on in their test tubes*'.

Reid and Shah (2007) discuss the place of experimental work and they conclude that students would pass examination just as well at the present time with or without the practical. However, practical work is popular and they consider that student attitudes towards their science courses would be different in the absence of practical work. Furthermore, they argued that, even students do not become biologists, doing laboratory work is important to gain a right understanding of how science operates.

Reid and Shah (2007) discuss the aims of practical work and argue that there needs to be a clear statement of what students gain from the experience. Looking at university chemistry laboratory classes, Kirschner and Meester (1988) suggested *students-centred* objective for laboratory work.

"(1) To formulate hypotheses
(2) To solve problems
(3) To use knowledge and skill in unfamiliar situations
(4) To design simple experiments to test hypotheses
(5) To use laboratory skills in performing experiments
(6) To interpret experimental data
(7) To describe clearly the experiment
(8) To remember the critical idea of an experiment over a significantly long period of time."

Carnduff and Reid (2003) suggested some aims for chemistry laboratory work, again at university level:

"(1) Skills relating to learning chemistry. There is opportunity to make chemistry real, to illustrate ideas and concepts, to expose theoretical ideas to empirical testing, to teach new chemistry.

(2) Practical skills. There is opportunity to handle equipment and chemicals, to learn safety procedures, to master specific techniques, to measure accurately, to observe carefully.

(3) Scientific skills. There is opportunity to appreciate the place of the empirical as a source of evidence in enquiry and to learn how to devise experiments which offer genuine insights into chemical phenomena.

(4) General skills. There are numerous useful skills to be gained: team working, reporting, presenting and discussing, time management, developing ways to solve problems."

Looking at the various lists, some of the outcomes are directly applicable to school biology courses. Perhaps, the key aims for school biology experimental classes might be to give opportunities to:

(1) Illustrate ideas and concepts of biology and to expose theoretical ideas to empirical testing.

(2) To learn some general skills related to scientific enquiry: appreciate the place of the empirical as a source of evidence in enquiry, to learn how to devise experiments which offer genuine insights, to measure accurately, to observe carefully, to draw valid conclusions.

One of the problems in much laboratory work is that of information overload. Johnstone and Wham (1982) developed the following model (see figuire 2.9, overleaf) to illustrate the problem. When students have working memory overload, their actions can often be seen as "*recipe following, concentration on one part excluding the rest, busy random activity, copying the actions of others and role of ' recorder'*." Students cannot understand and just copy down what is required of them. They then get bored and give up trying to find the meaning of the experimental work. Johnstone and Wham (1982) suggest that the teacher needs to take actions like: "*reduce the extraneous noise, organise the material and take pupil into his confidence*."

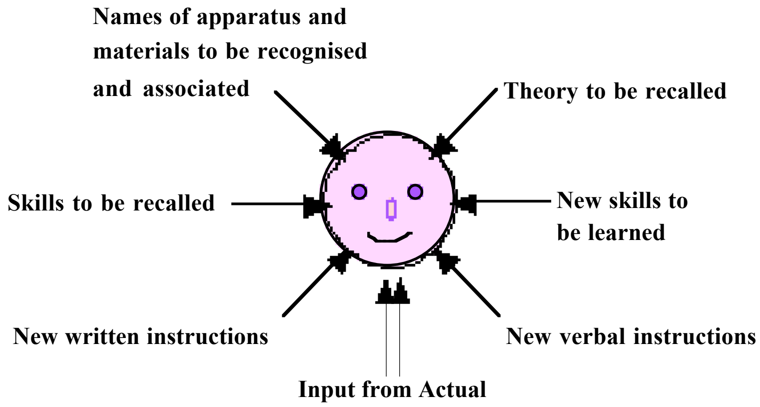


Figure 2.9 Information Overload

According to Johnstone and Wham (1979), there are two weakness for undergraduate students when they do experimental work. The first one is lack of sufficient skills and the second one is too much things to do on the other hand with little responsibility for themselves. It could be said the same thing for junior high school and high school students (age 12-18). Therefore, it is necessary to give students enough explanation about what they do and they should be encouraged to think freely by themselves.

Based on an analisis of the literature findings, Reid and Shah (2007) offer some guidance (Table 2.5).

Stage	Activity	Tasks
Planning	Have Clear Aims	Make biology real Expose ideas to empirical testing Develop skill of observation, deduction and interpretation Develop general practical skills (e.g. team working)
Before the Laboratory	Pre-labs	Share aims for experiments Establish background information Plan experiments
During the Laboratory		Keep instructions brief Allow experimental freedom
After the Laboratory		Apply ideas learned in a 'real-world' setting For assessment, look at process not 'right' answers

Table 2.5 Summary of Recommendations (Adapted from Reid and Shah, 2007)

2.7 International Comparisons

According to the result of the **P**rogramme for **I**nternational **S**tudent **A**ssessment (**PISA)** (OECD, 2000, 2003), in the Science section, Japanese students, who are between 15 years and 16 years old, showed a very high performance for each year and it could be considered that there are no serious effects from *less strenuous education* and it seems this new policy is going very well. In addition, they reported that scores among higher-performing Japanese students have increased and lower-performing one have decreased from PISA 2000 to PISA 2003 and Japanese performance on the science scale is statistically significantly above the OECD average in 2003.

Another result is obtained from TIMSS 2003 (Trends in International Mathematics and Science Study 2003) (see table 2.6 which shows the data for grade 2 of junior high school, age about 13-14). Japanese students' expressed interest towards for learning science have increased from 10 to 17.

%	Expressed positive attitude towards studying science		Expressed moderate attitude towards studying science		Expressed negative attitude towards studying science	
	2003	***1999***	***2003***	***1999***	***2003***	***1999***
grade 2 in Japan	17	10	56	60	27	30
grade 2 international average	57	40	31	49	12	10

Table 2.6 Japanese Students' Expressed Interest Towards Learning Science

However, a comparison between Japanese result and the international average shows high level Japanese students are 40 points below the international average and it reported Japanese result is one of the lowest percentage of the world. According to the Ministry of Education, Culture, Sports, Science and Technology(a), it was concerned that Japanese students are good at memorising and calculation but they do not acquire education which is ability of critical thought and expressing themselves. Furthermore, they indicated Japanese students think study is important but loving study is not necessary and many students do not have good learning habits. Asahi news paper (2004) in referring to Takigawa (2004) reported only 10 to 20% third grade students in Japanese high schools think that the subject Science is important while more than 50% students think the subject English is important. Furthermore, there are some research about the average of studying time at home. Japanese students' result is 6.5 hours per a week and it is 2.4 hours shorter than OECD's average (PISA 2003).

Okabe, Tose and Nishimura (1999) note the comments of Namikawa (1999) who indicated that there is tendency for students to like to have an answer for a question immediately and they do not think the process of thinking is important. Moreover, they try to find the answer which the teacher likes. Therefore, it might be hard for Japanese students to express their mind and ponder deeply. However, it is necessary for students to have much basic knowledge to make sense of the way biology applies in life as well as to pass the examinations and teachers often see themselves as helping student to achieve this and thus make the students' life comfortable.

There is teaching from the tea ceremony (Japanese traditional culture) and it said that it is important to know three states; Shu, Ha and Ri. Shu means *learning earnestly*, Ha means *polish what they learn* before and Ri means *establishing their own style*. It implies two significant things (Nishimura, 1999, referred from Okabe, Tose and Nishimura, 1999). *Less strenuous education* looks less Shu (*learning earnestly*) and Ha (*polish what they learn*) with more emphasis on Ri (*establishing their own style*). Nitobe (1988) described about knowledge.

> *" (knowledge) was not pursued as an end in itself, but as a means to the attainment of wisdom. Hence, he who stopped short of this end was regarded no higher than a convenient machine, which could turn out poems and maxims at bidding. Thus, knowledge was conceived as identical with its practical application in life; and this Socratic doctrine found its greatest exponent in the Chinese philosopher, Wan Yang Ming, who never wearies of repeating. 'To know and to act are one and the same'".*

> *"'Learning without thought,' said Confucius,' is labor lost: thought without learning is perilous.'"*

However, it could not be said that these phenomenon are caused only by *less strenuous education.* It is possible that there is a lack of students' social experience and natural experience (Ministry of Education, Culture, Sports, Science and Technology(a)). In Japan there is concern about the lack of enthusiasm not only for science but also for mathematics. Matsumoto (1999) observes that mathematics sometimes cannot be justified easily in terms of its immediate use but may be immensely valuable later on when applied in many areas of the sciences and technologies.

Therefore, students need mathematical (science) knowledge and teachers could encourage students and teach importance of having Shu (learning earestly) and Ha (polishing what is learned) in science classes. Namikawa (1999) described the importance of taking time when students learn something at the beginning and this kind of experience tends to give students the pleasure of understanding, thus reducing excessive frustration.

In 2002, the Ministry of Education, Culture, Sports, Science and Technology has changed its slogan from *less strenuous education* to *definite scholastic ability* and they encourage teachers to have *intelligible classes* (classes which are easy for students to understand). Moreover, there are reports on the growth of scientific festivals, scientific TV programmes and science centres. 73,000 people attended a scientific festival in 2004 and 1,500,000 people visited the Nihon kagaku mirai kan (Science museum) from 2001 to 2004. Opinions polls (Ministry of Education, Culture, Sports, Science and Technology, 2004) suggest that 65% think there are not enough places or opportunities to gain scientific knowledge. Over 50% think it is not difficult to understand if opportunities were available. 87% indicated they got scientific information from TV in 2004. Fortunately, there are many scientific TV programmes in Japan. Therefore, it would be possible to use them in science classes. Furthermore, teachers also can encourage students not only presenting science in the class but also informing about scientific facilities and events. Despite this encouraging picture, the evidence suggests very strongly that it is what goes on the classroom which attracts students towards the sciences (eg. Skryabina, 2000). This is consistent with the observation that all this activity has not led to a great upsurge in interest in studying in the sciences in Japan.

In looking at international comparisons, there is a real danger that results can be highly misleading with international survey such as OECD's PISA. Not only do curricula vary enormously between countries but also there are very considerable cultural differences in the way subjects are taught and examined. The school pupils have very different experiences and expectations. They face different kinds of assessments in their own countries. Therefore, comparisons can be highly misleading. Not too much can be made of such comparisons.

2.8 Teacher Training Courses

In Japan, it is necessary for teachers to be educated through teacher training courses which give the teacher's certification to practice. Generally, teacher training courses are in Junior Colleges, Universities and Post-graduate Schools. However, if a student graduates from a Faculty of Education, then they gain this certificate automatically while students from other faculties have to take extra courses. During taking teacher training courses, people take two kinds of subjects: courses related to the subjects to be taught and courses related to teaching. For example, a teacher who has graduated in, say, biology will take courses in biology and in the teaching of biology and then be asked to teach biology; however, a graduate in, say, agriculture, may end up being qualified in science and teach all four disciplines (biology, chemistry, earth science, physics).

An example below is given to show what students have to take in Meiji University in Japan (2007):

Requirement for acquiring teacher's certification of science

・have to graduate university
・have to acquire *The subject regarding subject* (for example biology, animal production and animal behaviour etc.)
  for Junior high school more than 20 credits
  for High school more than 20 credits
・have to acquire *The subject regarding school teaching* (for example science educational system, instruction on students and education practice
  for Junior high school more than 31 credits
  for High school more than 25 credits
・have to acquire *The subject regarding subject or school teaching* (for example pedagogy, psychology for youth and moral education)
  for Junior high school more than 31 credits
  for High school more than 25 credits
・have to acquire the Japanese Constitution
・have to acquire physical education
・have to acquire communication with foreign language
・have to acquire manipulation of information processing
・have to acquire experience of care worker (for Junior high school)

There are some exceptions but usually when people would like to have teacher's certification, education practice has to be done and it takes between two weeks and eight weeks in a junior or a high school (depends on the school). The purpose of educational practice is to face the problems associated with teaching and to learn the basic skills through the working experience in school (Tokyo University, 2000).

During education training, a practice student joins almost all educational activity under guidance from an instructor or head teacher. For example, he would learn how to inform students with a homeroom teacher during homeroom period, he would visit other teachers' classes and observe how to work with classes, preparing teaching materials with instructor and have classes, have open classes at the end of the course and sometimes doing school duties with other teachers.

There are some problems. A practice students tend to focus on teaching method because of the short period of education practice. Furthermore, teaching certification can be valid forever and, therefore, some practical students think having teaching certification is useful in their future - 'just in case'. Schools are aware that some students have taken the certification with little commitment and they often choose not to employ such students.

2.9 Examination Systems

In Japan, there are two types of junior high schools and high schools which have different semesters. Two semester schools have regular examinations twice or four times a year and three semester's school have three or six times a year. Usually, there is an examination at end of the each semester and the Japanese government recommends to do what it calls 'absolute judgement' (Ministry of Education, Culture, Sports, Science and Technology Government guideline for teaching brochure for teachers (b)). This is essentially a form of criterion referenced assessment. Johnstone *et al.* (1983) raised serious doubts about this approach to assessment but it does sound attractive. Instead of measuring student performance and putting the students in an order of merit where their performance are relative to each other, the attempt is to define precise standards and see whether each student meets these. The problem is that only experience with the norms can lead to any definition of the standards and only certain types of skills can be defined with any clarity.

In Japan, four areas for junior and senior high schools are :

Interest, desire and attitude;
Thought and judgement;
Technical skill and expression of observation and experiment;
Knowledge and understanding.

It is very difficult to do 'absolute judgement' because teachers need to examine inside a person and the scope for teacher's bias is considerable. To avoid the situation, teachers usually use all kinds of evidence, such as records of ongoing assessment; students notes and experimental reports, reports on research. All kinds of complicated symbolisms have been developed to assist the teachers in making such assessments. Whether such an assessment carries any validity and reliability is open to question.

According to the Ministry of Education, Culture, Sports, Science and Technology's survey in 2006, there are 97.7% students who go on to high school in Japan (age 15+). There are three types of high schools; full-time course high schools, part-time course high schools and high schools with correspondence courses. 92% students go to full-time high schools (surveyed by Japanese government on May in 2006). Students entry to high schools on the basis of general admission examinations or by recommendation (usually for students who are brilliant for sports, art and some special talent). Thus, examination performance is critical and affects the curriculum and ways of teaching and learning.

The Ministry of Education, Culture, Sports, Science and Technology reports, in 2006, state that there are 47.3% of high school students who go to university, junior college and technical college in Japan. Examinations again dominate entry procedures although there is enormous diversity, with some universities depending on one subject and others on up to nine.

The contents of general admission examinations for public high school has changed from testing how much students recall knowledge to an attempt to measure how well students can apply knowledge. However, two-third of the questions are computer-graded but the aim is that such questions cannot not be solved using knowledge but only by applying their knowledge. This is not easy and there has to be doubt if the test are actually measuring what they claim to measure.

2.10 Biology in Japanese Schools

In Japanese junior high school (age 12-15), a biology lesson starts as part of general science classes. Students are supposed to obtain a general idea of biology, chemistry, physics and geology equally. In biology area, students learn structure and classification of animals and plants, observation of organism, structure of cells of organism, reproduction and investigation of environment.

Pupils can choose to study biology at high school but the pupils have to decide a school before they enter. In high school (age 15-18), many schools offer a general science course at the first grade (age 15-16). General science can be divided into general science A (physics and chemistry) and B (biology and geology). What is offered varies from school top school. Biology in general science B mentions ecosystem, similarity of all organism, evolution with history of the earth, genetics and variety in organisms.

There are two kinds of pure biology: Biology I and Biology II. Sometimes students can decide what course they would like to take but again, usually school already decides whather students take biology classes and if students take science course, the possibility to take biology classes. Biology I includes cells, embryology, genetics, stimulus and response of animals and plants. Biology II can be studied after finishing Biology I and it includes protein, function of body, genetics, mutiplicity of organism and enbilonment surrunding group of animals.

2.11 Conclusions

This chapter has given a brief overview of biology education at school level, its place and purpose, problems in understanding as well as broad picture of what is happening, especially in Japan with reference in particular to Scotland.

It is good idea a biology teacher knows where the subject fits within the whole curriculum and, indeed, what biology education can contribute to school pupils in terms of understanding themselves, understanding their world and preparing for life beyond school. However, there are some difficulties in learning biology: for example, there are many technical words and some mathematical ideas. Difficulties arise when the working memory is overloaded.

There is concern about the *less strenuous education* programme in Japan and what people claim is a decline in scholastic ability. If Japan is to generate students from school who are going to take the country forward in areas depending on biology, then it is important that these students are not only equipped to cope but that they also possess positive attitudes towards biology education. The area of attitudes in the focus of the next chapter.

Chapter 3

Attitudes - a General Background

3.1 Definitions and Importance of Attitudes

Attitudes tend to influence behaviour and, therefore, can be seen as an important aspect of education (Reid, 2006). However, most school curricula make little reference to attitude development, placing much more emphasis on the development of skills of knowledge and understanding (see, for example, Standard Grade Arrangements in Biology, 2006). This chapter seeks to offer a brief overview of the main outcomes from the work of social psychology in relation to attitude research in general and then to apply this to the context of school education, specifically in relation to biology education.

Social psychology started to take the study of attitudes seriously in the late 1920s. At that time, psychology was dominated by a behaviourist viewpoint which stressed that it was not possible to measure what could not be observed directly. As attitudes could not be observed directly, their measurement was regarded with great suspicion.

In 1929, Thurstone, one of the first persons to investigate the problem of attitude measurement, described an attitude as '*the affect for or against the psychological object*'. This laid great emphasis on the affective nature of attitudes but it did not take into account that attitudes involved also the cognitive and the behavioural. A few years later, Likert (1932) used a much less precise definition, referring to a '*certain range within which responses move.*' This seemed to emphasise the behavioural.

Allport (1935) gave a definition which combined ideas from both Thurstone and Likert and talked about '*a mental and neural state of readiness to respond, organised through experience, exerting a directive and / or dynamic influence on behaviour*'. This definition is still widely used today. It emphasises the way attitudes may influence behaviour while being vague about the the cognitive and affective.

In 1948, Krech and Crutchfield (1948) took a new approach suggesting that attitudes have aspects of problem solving and, therefore, people learn something new. Afterward, Doob (1947) followed his viewpoint suggesting that attitudes were '*attempts at solution*'. In other words, attitudes allow the person to make sense of something. They offer some kind of evaluation and analysis so that a person knows how to react.

Johnstone and Reid (1981) indicated that any attitude definition involved three main components: cognitive, emotional (affective) and action-tendency (behavioural). In 1992, Oppenheim summarised all the definitions and suggested the modern interpretation for the attitudes definition that would be '*acceptable to most researchers*' (Ramsden, 1998):

> *" attitudes...[are]... a state of readiness or predisposition to respond in a certain manner when confronted with certain stimuli...attitudes are reinforced by beliefs (the cognitive component), often attract strong feelings (the emotional component) which may lead to particular behavioural intents (the action tendency component)".*
>
> (Oppenheim, 1992)

The main feature of the definition Oppenheim is the involvement of three components: cognitive, affective and behavioural. Many years before, Rhine (1958) stressed that evaluation is important feature of attitude as distinguishable component from mental states and considered an attitude as a '*concept with evaluative dimension*'. Eagly and Chaiken (1993) brought this idea to the fore when they stated that an '*attitude is a psychological tendency that is expressed by evaluating a certain entity with some degree of favour or disfavour*' (Chaiken and Eagly, 1993).

This definition brings together many of the previous insights. The latent construct nature of attitudes is stressed by the emphasis on the psychological tendency while the evaluation is made central. Indeed, an attitude towards something or someone is something which is developed in the brain and may not be overt at all. The attitude arises because the person, with some kind of knowledge, experience and feeling, evaluates the person or thing in some way.

Many years ago, Reid offered a definition of attitude and this can be adapted in the light of more recent contributions as shown in figure 3.1. The three dimensions cognitive, affective and behavioural) are present but there is no assumption that they are of equal importance in all attitudes.

Network
of
cognitive, affective and behavioural elements
with an
evaluative dimension
tending to influence
Behaviour

Figure 3.1 Attitude Definition (after Reid, 1978)

One of the major problems in the attitude literature is the way different authors use different words. Words like 'attitudes', opinions', 'beliefs' are often used and the exact distinction is not always clear. A recent analysis offers some insights (Oraif, 2006). In this, attitudes can be seen in terms of beliefs which depend on the evaluation of knowledge (as well as affect and behaviour).

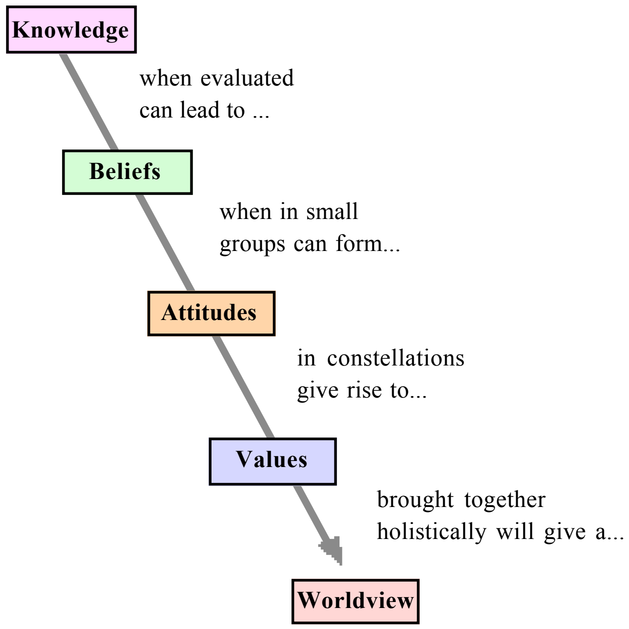


Figure 3.2 Possible analysis of Attitude-related words (after Oraif, 2006)

The approach adopted by Oraif attempts to relate some of the words to each other. However, the word 'belief' (and sometimes 'view', 'opinion' or 'perception') is sometimes used interchangeably with the word attitude. Perhaps, it is better to reserve the word attitude to refer to groups of cognate beliefs. Thus, a student might be said to have a positive attitude towards biology and this could be seen as being based on positive views relating to learning experiences in biology, laboratory work in biology and even the biology teacher.

3.2 Attitude Development

There are very many theories which have attempted to offer explanations of the way attitudes can change and develop. Indeed, there are too many theories and some are fairly limited in scope (Johnstone and Reid, 1981). Each theory has tended to arise from a series of research experiments and, together, they can offer some kind of overall picture of the conditions under which attitudes may change. In the context of education, it is possible to group many of these theories under four general headings.

One group of theories emphasises that attitudes have a purpose for humans and that the development of attitudes can be understood if the purpose is understood. Attitude development often takes place by some kind of communication between one person and another. Much research has focussed on the communicator while other work has focussed on the method of communication. Finally, some research has explored the mechanisms which operate in the brain when attitudes are likely to change. Each of these emphases is now discussed in the following sections.

3.3 Attitudes have a Purpose

Katz (1960) describes the motivational bases of attitudes and suggests four functions which attitude can have. He argues that knowing these possible functions can offer insights into how and why attitudes might change or develop. Thus, in the context of attitudes towards biology, such attitudes will develop for a purpose and will bring some benefit to the person involved. Each is now discussed briefly.

(a) *Adjustment function*

'*People strive to maximise rewards in their external environment and minimise the penalties*' (Katz, 1960). Attitudes are likely to develop in order to achieve this. Thus, positive attitudes will develop towards educational experiences which are associated with satisfaction of needs and negative attitudes will develop when the needs are not being satisfied. Looking at biology, students might develop positive attitudes if they see their biology course as making sense of their world around, leading to a desired career possibility or stimulating their curiosity and interest. Negative attitudes may well arise if the subject is perceived as irrelevant, they cannot pass examinations or even receive any praise from the teacher.

(b) Ego-defensive function

People originally protect their weak aspects, arising perhaps from unacceptable personal impulses, awareness of external problems and even anxiety. Attitudes here may lead to hesitation, denial or rationalisation. Attitude are formed in this way as a means of defending internal inadequacies. Thus, attitudes are formed in order to offer an internal defence for the individual person. In a Japanese context, students often think it is shameful to make some mistake or to express their opinion in front of others even if it is correct. They are protecting themselves from perceived social failure. This has important implications for learning where mistakes and misunderstandings, openly acknowledged, can often lead to much better understandings.

(c) Value-expressive function

When people can express themselves or personal values, they are satisfied because expression supplies protection of their self-image. Thus, self perception tends to direct attitudes. Attitudes thus develop to enhance one's own central values and to be consistent with the person conceived to be. This is an aspect of making sense of oneself. Attitudes reflect the inner value systems.

(d) Knowledge function

Knowledge would help people to understand the world in which they live and it also enables them to adapt to their world easily. In a sense, it brings order and clarity, it makes sense of things around. In the biology class, there are many phenomenon which teacher can introduce to students: for example, how environmental pollution affects humans, why human have diseases and what causes similarity between parents and children etc. Teacher can involve students in such problems and discuss questions by means of experimental work and role-playing.

In looking at the work of Katz, his key contribution is to emphasise that people develop attitudes for reasons and any attempt at attitude development must take these reasons into account. In childhood, the attitudes which develop will be social directed and reflected the cultural norms to a great extent. Many will be accepted uncritically and will develop in order to be socially acceptable in the family and wider society. The development of attitudes in educational settings must take the work of Katz into account and allow the learners to begin to appreciate some of the inadequacies of their current attitudes as well as some of the benefits which new attitudes might bring.

The work of Katz (1960) was linked to contributions from others as well as influencing others. Among these, McClintock (1958) outlined the importance of personality when attitude change is considered. Attitudes are not the same as personality but attitudes are likely to be influenced by personality. Kelman (1958) stresses that '*attitude changes must involve elements which are intrinsically satisfying or rewarding*'. This emphasises strongly that attitudes have a purpose and that the development of attitudes enables the person to make more sense of the events and circumstances of life.

Building his ideas on those initiated by Katz (1960), Reid (2003, page 33) sees the purposes of attitudes as revolving around three general areas:

Attitudes "*allow us to:*

(a) Make sense of ourselves;
(b) Make sense of the world around us;
(c) Make sense of relationships."

It is often thought that education is little more than subject instruction and that the successful student is the one who can answer examination questions most accurately by recalling and explaining what has been taught (see Hindal, 2007). School education has a much deeper purpose and this revolves around preparing the student for life beyond school. Much that is taught, memorised and reproduced in examinations at school is largely forgotten a few years later. However, attitudes towards themes studied, teachers or subjects often remain for years to come. The development of such attitudes is part of the preparation of students for life beyond school.

Having discussed the purposes which the development of attitudes might have for the learner, it is now important to consider the ways by which one person might influence another in the development of their attitudes.

3.4 Communicators which can Enable Attitudes to Develop

One of the powerful influences which enables attitudes to grow and develop is contact with other people. For very young children, the role of parents may be critical while, with primary aged children, the teacher has a powerful influence. At secondary stages, the teacher still has a powerful influence although the influence of parents tends to fall (see Skryabina, 2000). This section focusses on the communicator.

Considerable research work has offered some valuable insights into the role of the communicator. Much of the early work was pioneered in Yale University many decades ago by Hovland and his team (Hovland *et al*, 1957). Later, Reich and Adcock (1976) stressed the important point that any communicator has to have high credibility in the eyes of the students. Their study concludes that '*subjects agreed with the experimenters' assumptions of the relative trustworthiness of these sources.'* and credibility sources affect attitude change. Himmelfarb and Eagly (1974) found that the material which has high credibility but is unimportant also can change people's attitude. In addition, the communicator also should be able to stimulate a students' scientific mind.

Reich and Adcock (1976) in referring to McGuire (1968), pointed out two important components to persuade people. '(a) comprehension, and (b) yielding.' Firstly, the communicator must be understood. However, even if the communication is understood, there is no certainty that the person will change their attitude. It seems that the communicator must take things step by step. Thus, each time teachers provide enough information to students then to go on the next step (Reich, 1976, referring to Hovland, Harvey and Sherif, 1957). McGuire (1968) considers the comprehension component is positively related to intelligence. It is also important to have an opportunity thinking time for because students need to make sense how related teacher's information to their life.

3.5 Communications which can Enable Attitudes to Develop

A teacher would always like to think they are giving students beneficial information for their life. However, students sometimes do not connect this information with their life. Therefore, the message should not only be just knowledge but also be a useful tool for student's future. Johnstone and Reid (1979) note that '*If an attitude develops without taking the cognitive base into account, then this attitude can well be described as a prejudice*'. To persuade students more impressively, the way of communication should be considered. This section focusses on the communication. Much research has offered some key insights and this is summarised in Chaiken and Eagly (1993).

First of all, the messages should be related to students' existing feelings and beliefs. They must be perceived as relevant. The learner must be sufficiently motivated to pay attention. Secondly, the learner needs to be actively involved with the incoming information. All kinds of group work activities and, especially, role play have been found to be very effective. However, the activities or role play must not involve any kind of coercion. Indeed, it appears that there needs to be a significant amount of freedom so that the person can develop the role in their own way. When students role play, they should have personal responsibility for their role. Overall, the communication is best seen in terms of active involvement. This has considerable implications for school education where most learning tends to be passive and students receive information and understandings from teachers or written resources (Eagly and Chaiken, 1993).

3.6 Internal Mechanisms of Attitude Development

While it is important to observe the nature of the communicator and the method of communication in enabling attitude development to take place, it is more difficult to find out what are the internal mechanisms in the brain which are important. However, over the years, considerable work has built up which offers some very important insights. Much of this centres on the human need to be reasonably consistent in thinking.

Cognitive elements can be expressed using an affective unit such as 'like' and 'dislike'. Originally people do not like inconsistency between elements existing in their minds and, thus, it is possible that such inconsistency may bring about attitude change: disagreement, disharmony or inconsistency are all mentally uncomfortable (Reid, 1978). However, there may be big resistance to change an attitude if one element is completely opposite of other one (Scott, 1957). Fishbein and Hunter (1964) consider that attitudes are to be seen as a function of the sum of cognitive elements and they throw some light on the way these are organised.

There are three approaches from cognitive and dissonance's aspect:

(a) Those based on Heider's Balance Model;
(b) Osgood's Congruity Principle;
(c) Festinger's Dissonance Theory.

Each is now discussed briefly.

(a) Those based on Heider's Balance Model (1944)

Heider suggests a perceiver (P), other person (O), object (X) and two possible relationships: like or dislike. The below model has $8(2^3)$ possible 'like-dislike' relationships:

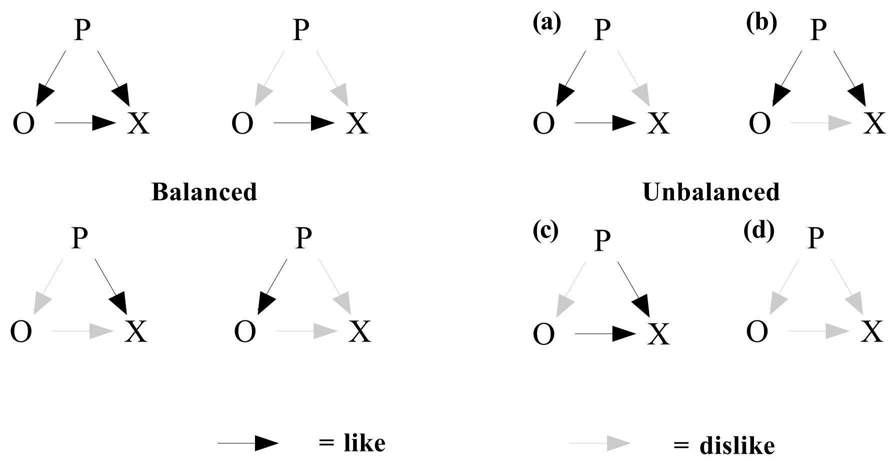


Figure 3.3 Balanced and Unbalanced Relationships

Heider argued that an unbalanced relationship will be unstable and may lead to attitude change. Of course, this theory can be criticised because the relationship between people and people has not so simple such as his balance model suggests and there are many interactions. However, the model has been modified and developed by Horary and Cartwright (1963). Indeed, the principle, although simple, makes much sense.

In order to look at biology, it is possible to replace (P) to Students (S), (O) to teacher (T) and (X) to biology lessons (B) and look at the unbalanced situations.

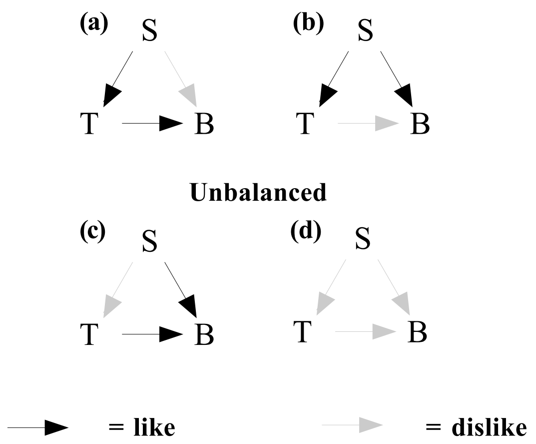


Figure 3.4 Unbalanced Relationship in Biology Education

When the teacher is positive about biology lessons [models (a) and (c)], it is not too difficult to see how the student attitude in (a) might change in order to produce a balanced situation. The teacher can develop learning situations and materials which will encourage a more positive attitude towards biology lessons.

In models (b) and (d), teachers do not have positive attitude towards for biology lessons. In (b), it difficult for the student to retain positive attitudes towards biology lessons. This suggests the critical importance of teachers always showing positive attitudes for their lessons. Heider's model is important because it led to the development of major refinements including the work of Osgood (1957) and Festinger (1957).

(b) Osgood's Congruity Principle

Osgood *et al*. (1957) considered how to measure attitudes from psychological and behavioural viewpoints and was influenced by learning theorists such as Doob (1947) who Heider (1944) as well as the early work of Festinger (1954). He suggested the way to measure attitudes which he called the semantic differential (SD). The method will be discussed later in detail (see Chapter 4).

An example illustrates his thinking. Person (A) is held in high regard by the subject but concept (B) is held in low regard by the subject. According to his model, when they interact with each other, their positions are drawn together. Therefore, it can be considered that teacher's positive attitude towards biology makes a student's attitude better. However, the need for interaction is critical and this offers an important insight.

(c) Festinger's Dissonance Theory

Janis and King (1954) studied when people are forced to do something which they did not want to. They discovered that, while opinions could be changed in this way, the changes did not last. However, Festinger and Carlsmith (1959) developed this and found that, when rewards were offered for doing what they did not want to do, the *smaller* the reward, the *greate*r the opinion change in a forcing situation. This was initially a surprising result.

He developed an understanding of what was happening by using the idea of dissonance. His famous experiment is now described briefly. Students were asked to do extremely boring task for a reward which was either one or twenty dollars. He used Likert type questionnaires (see Chapter 4) and found larger changes for one dollar reward on measures of 'enjoyment' or 'willingness to do it again'. There were very much lower attitude changes for the 20 dollar reward. However, there is a contradiction between the activity and the glowing report which is recorded on a tape during the experiment.

Festinger defined carefully what he meant by dissonance and consonance. He was thinking of behaviour and attitude which were not consistent in some way and he described this situation in terms of dissonance. Where behaviour and attitude were consistent, he saw this as consonance. Thus, in his experiment, the requirement to tell the next student that the task was interesting (behaviour) was in contradiction with the student attitude (based on previous experience) that the task was boring. What he appreciated was that the money reward added consonance to the task of telling the next student that the task was interesting. He saw that any attitude change which arose depended on what he called *total dissonance* which took into account the *actual* dissonance and the *actual* consonance. He defined this by a simple equation:

$$\text{Total dissonance} = \frac{\text{Dissonance}}{\text{Actual Dissonance} + \text{Actual Consonance}}$$

or

$$\text{Total dissonance} = \frac{|D|}{|D| + |C|}$$

The key thing to note is that, if the amount of consonance increases, then the total dissonance decreases. He then went on to hypothesise that any possible attitude change would be related to the total dissonance. Thus, in his experiment, the increased amount of consonance of the $20 reward reduced the total dissonance and, thus, there was less observed attitude change. The smaller $1 reward generated less consonance and, therefore, the *total* dissonance remained high and attitude change was greater.

He appreciated that there were alternatives in seeking to reduce the total dissonance. If total dissonance is very large, there are three other ways to reduce it:

(a) Changing belief and statement,
(b) Removing belief and statement, and
(c) Adding new belief and statement.

Festinger's work is reproducible (Eagly and Chaiken, 1993) and is widely accepted as offering a key insight. When key elements are in conflict and the conflicting elements interact with each other in some way, then dissonance arises. However, the possibility of attitude change or development is controlled by the total dissonance and this involves taking into account what is consonant as well as what is dissonant. Dissonance seems to be a natural process throughout life. The Festinger understanding makes sense of the observation that, when placed in dissonant situations, people tend to seek for consonant cognitions, affects or experiences in order to reduce the total dissonance and thus avoid attitude change. This preserves attitude stability and avoids disturbance.

3.7 Bringing it all Together

There are so many approaches to change student's attitudes described in the literature and it is very difficult to conbine all of them. In addition, these models usually apply in specific situations designed by the researchers. However, it is worth consideration what each model might offer to attitude development in the particular situation of the secondary school.

Katz (1959) emphasised that attitudes have purposes and that any attempt to change attitudes must take into account the needs of the individual and the way that the attitude change might be perceived as of value to that individual. In other words, attitudes serve a purpose for each human being in making sense of life. Attitude change will be resisted unless it enhances this.

Festinger's (1959) work on dissonance has offered very valuable insights However, it is not an acceptable way to change attitudes by forcing people to do something or offering monetary incentives like Festinger (1959) examined. Nonetheless, his understanding is immensely valuable in the school situation. It stresses that it is the *total* dissonance which has to be considered and this means that the extent of consonance has to be examined.

Indeed, the work of Osgood (1967) and Heider (1944) is important. They are picturing dissonance situations. It shows the critical importance of the relationship between the student and the teacher if positive attitudes towards a subject like biology are to be developed. This is totally consistent with the work of Reid and Skryabina (2002) when they showed the powerful influence of the teacher in attracting and retaining students in physics at school level.

Reid (1978) took the idea of Festinger and others further when he suggested that a likely key to attitude development was the bringing together of cognitive and affective elements in such a way that dissonance could occur. He then developed teaching resources which aimed to do this in the context of social attitudes relating to a school chemistry syllabus. He was able to show quite large attitude developments took place when these materials were used and he attributed it to the generation of dissonance in the students. The attitude developments seemed stable with time.

The behavioural-learning theorists insist that attitudes could change through learning. They looked at this by studying communicators and methods of communication. These were analysed by Reid (1978) and, from this, some simple principles were stated in the development of teaching situations where attitude development might be expected to take place. These included the perceived credibility of the teacher, the quality of the teaching materials, and, importantly, the structure of the materials os that genuine interaction might take place between what the leaner knew and what attitudes were held with new learning experiences. He talked of internal mental interactions and referred to these as 'intra-actions' (Reid, 1980; Johnstone and Reid, 1981).

This concept of 'intra-activity' has to be distinguished from interactivity. There are interactions between students, between a student and the teacher, and between a student and teaching materials. This is not what is meant by 'intra-activity'. Here, there is a suggested *internal* interaction between what is already held in long term memory and the new learning, feelings or experiences in the learning situation (see Reid, 1980).

One of the useful cognitive approaches to attitude development is by means of role-play. The concept of dissonance and the the idea of 'intra-activity' make sense of why role-play is found to be so powerful in attitude development. By placing learners in unfamiliar situations and allowing them the freedom to work in a different role, dissonance is highly likely and the extent of involvement which role play demands will mean that 'intra-activity' is more likely. Figure 3.5 summarises how Reid (1978) saw the concept.

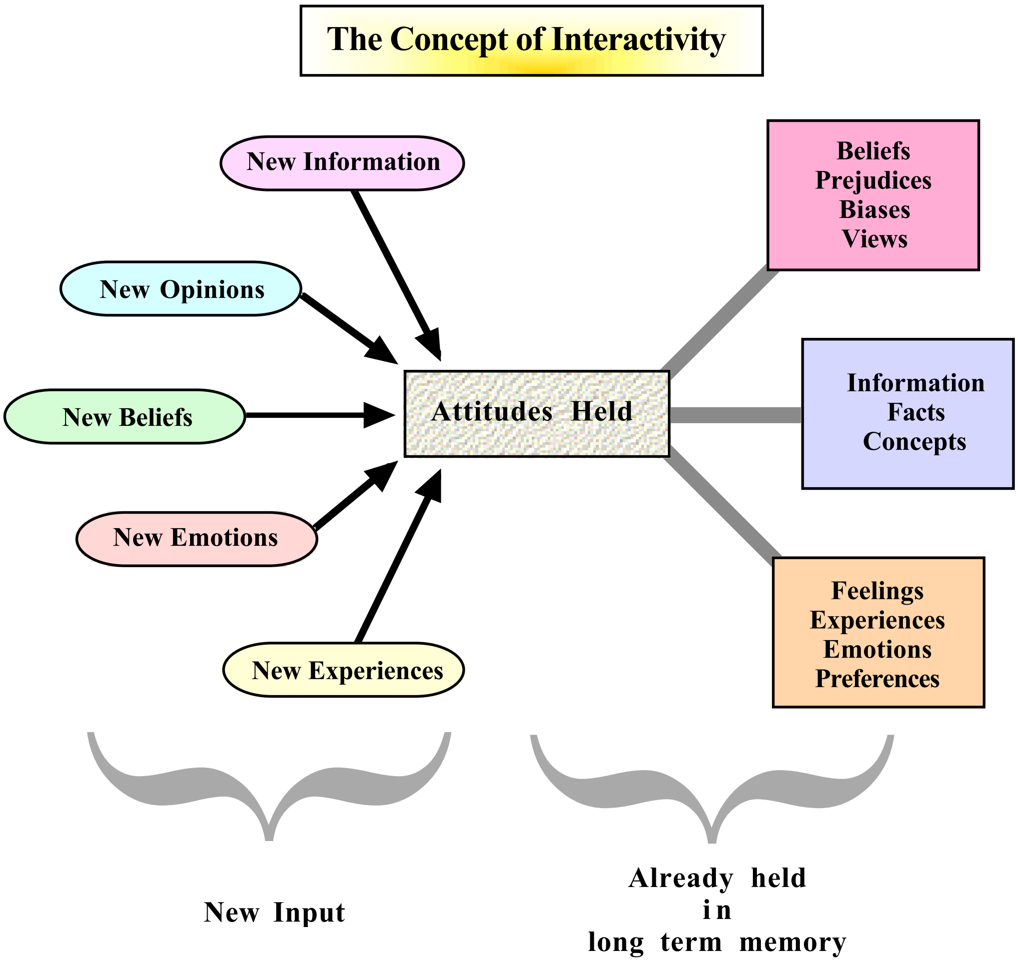
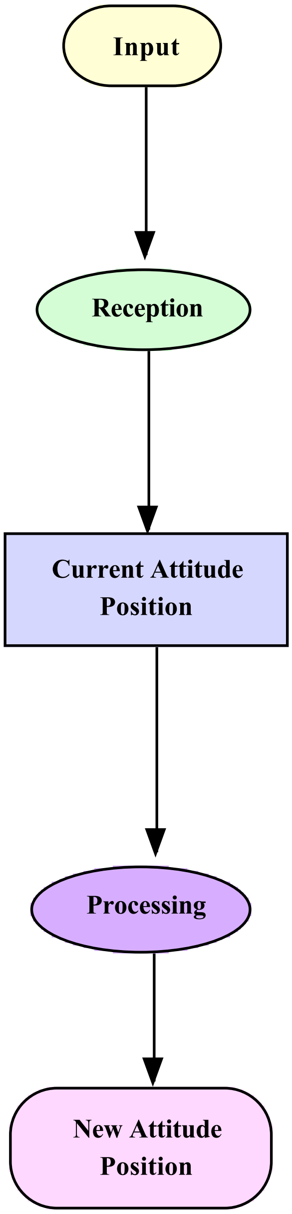


Figure 3.5 The Concept of Intra-activity

Much of the research on attitude development can be summarised in figure 3.6



Acceptable mode of presentation
Trustworthy source
Quality presentation
Balanced two sided
Perceived Relevance for Subject

Motivated to be willing to receive
Able to receive efficiently
Able to understand adequately

Cognitive and affective baseline
Established behavioural baseline
Held attitude position and strength
Embeddedness in matrix
Extent of internalisation
Extent of ego-involvement

Availability of appropriate cognitive route for processing
Scope to juxtapose relevant elements
Opportunities to internalise
Opportunities to articulate or express in behaviour (including role play)
Opportunities to assess functional value

Functional Gains:
Intellectual, personal, social

Figure 3.6 Summary of Attitude Development Research

3.8 Attitudes Within Science Education

Science teachers can be thought of as a people who have knowledge of the basic facts of their science, experimental and problem solving skills and favourable attitudes to their science. Therefore, it might be expected that they can encourage students' attitude development through science. However, teachers sometimes just concentrate on how to give students a knowledge of biology, with little emphasis on the application or significance of biology in the life contexts of their students.

In Japan, there are many students who question why they have to learn biology while, at at the same time, many teachers are concentrating on how they can finish all the contents of a biology textbook in a certain time. Allport (1961) notes that, if the school does not teach any values of science, students would deny them. Moreover, it might be impossible to provide education where there is no interaction between teacher and learner (Khan and Weiss, 1973). It is important to bring together the findings from attitude development research and what goes on in real biology classes.

Thinking largely of the cognitive, Mager (1962) insists that it is very important to show students what things demanded from students and Wolke (1973) said that teachers should not be just 'instructors' who give students knowledge. Of course there is criticism for what Mager and Wolke said. For example, Mager's understanding is not suitable for developing mathematical skills or practical skills and Wolke's message may offer inadequate insights from the perspective of certain science educational pedagogies because it sometimes ignore reaching any aims (Reid, 1978). However, it is very important to think about how to involve changing attitude theory in science education.

Reid (2003, page 32) has offered a simple analysis of the place of attitude development in teaching and learning in the sciences suggesting that there might be "*four broad areas where we might wish to explore attitudes in relation to students:*

(a) Attitudes towards subjects being studied;
(b) Attitudes towards study itself;
(c) Attitudes towards the implications arising from themes being studied;
(d) The so-called scientific attitude."

Looking at part (a), most work has been carried out in relation to physics and chemistry. The USA has led this work and this is because there is much concern about the popularity of these subjects (see Skryabina, 2000). The ways students study and their attitudes to study has also been a focus of much research. Perry (1999) carried out a very useful analysis at university level. However, little has been done at school level, the one exception found being the work of Al-Shibli (2003). Attitudes towards the implications arising from themes being studied was studied extensively many years ago by Reid (1980) under the title of social attitudes relating to chemistry but little has been done since. The scientific attitude (part (d)) is interesting: perhaps it is more a way of thinking than an attitude (see Reid, 1978, pages 43-45).

In looking at attitudes towards subjects like biology, there are two approaches, called Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB). These are quite successful tools for considering students' attitudes towards science and their subsequent decisions as to whether to continue studies in these areas (Skryabina, 2000). Both of these models were developed by Fishbein and Ajzen (1975).

3.9 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action assumes that human action is controlled by rational decisions. While this is not always true, for much of the time decisions are taken by most people on some kind of rational basis (Fishbein and Ajzen, 1975). According to the theory, human behaviour depends on the person's behavioural intentions. There are two factors which influence people's intentions to behave (Skryabina, 2000).

(1) The person's attitude toward the behaviour (AB);
(2) The person's subjective norm (SN).

The person's attitude toward the behaviour (AB) is built up on numerous beliefs about that behaviour (Petty and Cacioppo, 1981, p.194). The subjective norm is how the person thinks others will view the behaviour. Much of the work has focussed on whether students will choose to study physics (the behaviour) (see, for example Crawley and Black, 1992).

Numerous factors may influence the attitude towards studying biology. For example, following the line adopted by Crawley and Black (1992), with regard to physics, the following may be important:

The student needs to see the study of biology as a desirable goal. They may develop positive attitudes because biology is important in key careers (scientist, doctor, nurse etc.). The student may also see the desirable goals relating to work done in class as they see biology helping them to understand the world around and be able to solve meaningful problems. Indeed, there may be a simple satisfaction in their biological studies. This leads to the area of interest. Students need stimulated so that they find biology interesting. This may involve creative and imaginative teaching. People need scientific knowledge because to make sense of themselves, the world around and relationships. Students always would like to know what is happening around them (Reid, 2003, page 33). Of course a powerful aspect of attitude will be student confidence on gaining good grades. Therefore, it must be helpful thing to tell students what level they reach in biology classes.

The second factor found by Fishbein and Ajzen, (1975) is the subjective norm and this is the second predictor of a behavioural intention. According to the Theory of Reasoned Action, the key is how important the views of others are for students. Crawley and Black (1992) note what kind of people could influence for students.

(1) Parents/guardians,
(2) Brothers/sisters,
(3) Current teacher (in their case, physics),
(4) Friends,
(5) Counsellors.

According to the theory of reasoned action, the students behaviour depends on two factors: the person's attitude toward the behaviour; and the person's subjective norm (SN). These two components may not always carry the same weight. Moreover, according to the theory, each component is independent.

3.10 Theory of Planned Behaviour

After analysing much data, Ajzen (1985) found that the two factors were not adequate to explain behaviour intention. Therefore, he extended the theory of reasoned action into his Theory of Planned Behaviour. This allows for the factor that behaviour is sometimes not completely under the subject's control (Skryabina, 2000). Liska (1984) notes that most behaviour is either totally intentional or totally accidental. To allow for this, Ajzen (1985) introduced a third factor which he called Perceived Behavioural Control. In essence, this is exploring the possibility of the behaviour. It may be difficult (for example, the student lacks key skills, ability and knowledge to do something) or it may difficult if the the resources are not available. Among some of the factors considered by Crawley and Black (1992) in relation to taking a physics course are things like timetable conflicts, dislike of the likely teacher, fear of failure based on past performance.

The theory of planned behaviour can be summarised in figure 3.7 (Skryabina, 2000).

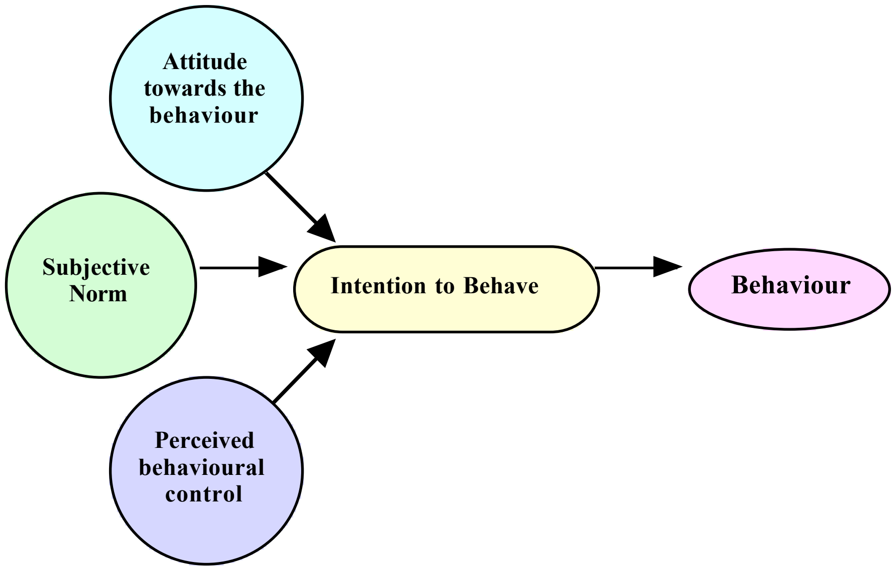


Figure 3.7 Theory of Planned Behaviour

In simple form, when thinking of some behaviour, the factors which control any intention to engage in the behaviour are the person's attitude towards the behaviour, what they think others will think of them if they do engage in the behaviour and, finally, whether the behaviour is possible. Ajzen (1985) found that the attitude factor was usually the most powerful of the three.

With regard to a decision to study biology, a person might intend to take a biology course or degree if they hold a positive attitude towards biology and the study of biology, if they think others will approve of this course of action, and if it is possible to do on the basis of grades already obtained and other practical considerations.

3.11 Attitude Research in Science Education

There have been a large number of studies relating to attitude towards science and patterns of enrolment. Many have found that the theory of planned behaviour offers a useful model for intentions of study a science (usually physics).

> *"...about seventeen per cent of the 113 at the National Association for Research in Science Teaching (NARST) 1983 meetings in USA were directly related to students attitudes. About thirteen per cent of the 588 dissertations in science education listed in University Microfilms International's (1982) Catalogue were directly related to attitudes... Gardner (1983) has noted that studies of attitude have been a continuing feature of the annual conferences of the Australian Science Education Research Association... In the UK a substantial number of theses and dissertations as well as scientific papers have dealt with science-related attitudes. These informal indicators all point to the importance afforded the affective domain in science education by researchers in Australia, the UK and the U.S.A". (Schibeci, 1984)*

The problem has been that, using the traditional methods of attitude scales, only the most general findings have emerged from all these studies (see Reid, 2006). Thus, for example, it has consistently been found that,

- Boys are more positive towards science than girls (Weinberg, 1995; Ramsden, 1998);
- Interest towards science decrease with age (Barrington and Henderriks, 1988; Simpson and Oliver, 1985; Piburn and Baker, 1993).

Sadly, these findings could have been revealed by any experienced and perceptive teacher. The much more fundamental question relates to *why* these are found to occur. The work of Reid and Skryabina (2002b) did not depend on attitude scaling methods at all (see Chapter 4) and offers a great deal of insight into the gender question. Indeed, their work is very suggestive about why attitudes decline with age. In their study in Scotland, such a decline in physics was *not* observed and they were able to relate the moves of attitudes to specific curriculum structures, topics studied and the way the teaching was organised. Thus, because girls tend to be more interested in the human dimension of the sciences, when a syllabus is a balanced between the human and the technical, then the interest of *both* boys and girls are served well. Equally, their study showed that boys and girls (and indeed, university physics students) wanted a curriculum where the themes to be studied were perceived as being related to the lifestyles of the learners in a meaningful way. This led to the idea of 'applications-led' curriculum (see Reid 1999, 2000). Reid argued that, if the curriculum in the sciences were constructed on this basis, then attitudes towards the science subjects would be enhanced greatly. He offered an example of where this was observed to happen.

Ramsay and Howe (1969) said that "*A student's attitude towards science may well be more important than his understanding of science, since his attitude will determine how he will use his knowledge*". This is another important aspect in that the outcomes from scientific enquiry are affecting lifestyles increasingly. Many years ago, Gardner (1975) remarked that a, "*person's attitude to science is a learned disposition to evaluate in certain ways objects, people, actions, situations or propositions involved in the learning of science*". Khan and Weiss (1973) give useful diagram to describe attitudes and its relationship with all the variables.

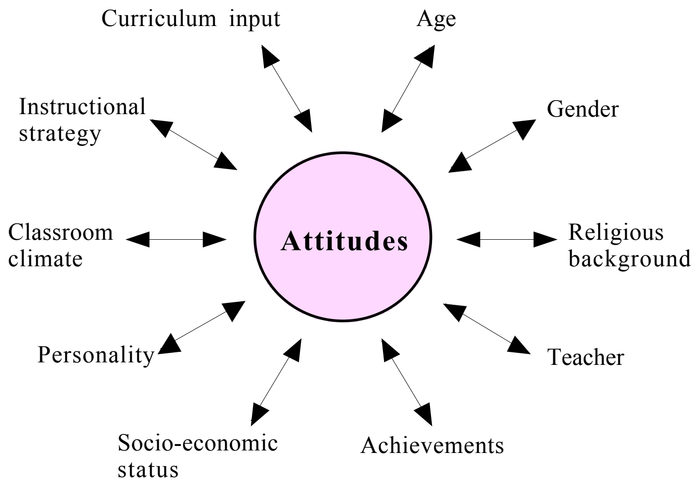


Figure 3.8 Attitude and its variables (Reid, 1978, derived from Khan and Weiss, 1973)

In fact, it is very difficult to research about attitudes because many factors influence the formation of a student's attitude (see Figure 3.8). Furthermore, it is impossible to observe an attitude directly since it has latent and complex structures. It might be easy to observe an attitude if researchers set very specific situations but the real world does not work in this simple way. It is difficult to judge students' attitudes when researchers are dealing with so many variables. However researchers tend to look a single element such as a teacher or achievement on the attitude towards science (Gardner, 1974; Schibeci and Riley, 1983; Schibeci, 1985).

Looking at figure 3.8, most of the variables cannot be controlled. The curriculum, the teaching strategy and the classroom climate may be controlled to some extent by the teacher. The assessment approaches may influence how the learners perceived their success. The next sections discuss some of the findings on some the variables in figure 3.8.

(a) Attitude and Achievement

Eisenhardt (1977), working with a large number of students aged 11-16 in West Virginia, USA in Science, Mathematics, Social Studies and English indicated that he found achievement influences attitude rather than opposite. However, Schibeci and Riley (1983) had the opposite result. From social psychology area, both of them could be explained using the theories. Therefore, there is a possibility of "*two-way relationship between attitude and achievement*" (Schibeci, 1984).

Many researchers study how attitude and achievement should link. Based on many results, in 1982, Fraser conclude that "*if teachers want to improve achievement, they would be well advised to concentrate on achievement "per se" instead of trying to improve achievement scores by improving attitudes*". Moreover, Schibeci (1984) insists "*it is not necessary for the students to* ***enjoy*** *science*". However, some researchers still believe current attitudes are more important than their achievement.

Barrington and Hendericks (1988) investigated intellectually gifted (IQ > 130) students and non-gifted science students in the USA. Their conclusion is that gifted students are more attracted towards the science classes than non-gifted students because gifted students have much knowledge of science and understanding its concepts. Such a conclusion is hardly surprising!

Weinberg (1995) looked at gender issues and found that, as "*as attitudes became more positive, achievement tended to increase*". Again, this is totally unsurprising. However, she noted gender differences, concluding that, "*a positive attitude is more necessary for girls in achieving high scores than for boys*". In addition, it was found that the relationship of attitude-achievement in Biology is higher than in Physics.

The relationship between achievement and attitude is not straightforward. Some studies claim that the former influences the latter while others claim the reverse. In all probability, it is simply a matter of a two-way relationship: good attitudes encourage good learning; good learning encourages good attitudes.

(b) Attitude towards science and age

Piburn and Baker (1993) as well as Ramsden (1998) found similar patterns of students' attitudes towards science with age and that, "*as pupils grow up their attitudes towards science decline*". Similarly, in the 2003 Trends in International Mathematics and Science Study (TIMSS2003) variation of interest towards for science from primary grade 4 (age 9-10) and grade 2 (age 13-14) in Japan was considered (see Table 3.1). The study found that the number of students who are willing to study science decreased from primary grade 4 to junior high grade 2. Ramsden (1998) found generally there is also decline of positive views towards science and this is particular true for girls.

%	Very Positive		Neut ral		Nega tive	
	2003	***1995***	***2003***	***1995***	***2003***	***1995***
Primary grade 4 in Japan	45	38	36	50	19	12
Junior High grade 2 in Japan	19	8	40	45	41	47
Junior High grade 2 international average	44	23	33	49	23	28

Table 3.1 Primary Grade 4 and Junior High Grade 2 Interest in Science

Hadden and Johnstone (1982, 1983) examined the erosion in positive attitudes towards science in Scotland over the first two years of secondary (ages 12-14) and found that the decline was greater than that for mathematics and geography.

Piburn and Baker (1993) explored the reasons why students' attitude in the US had decreased. When pupils are in primary school, they like science and have many science activities with open-ended and action-oriented work in science classes. After they go to junior high school, they usually need tuition, assessment and examination more than before and at that time, to have open-ended activities are also more difficult because students need more knowledge related to these activities. In the high school level, students are required to have a "*strong work ethic and seemed to appreciate schoolwork, including tests, which they believed helped them to learn*". Therefore, students realise science classes become more abstract and complex and this influences students to negative attitudes. Piburn and Baker (1993) suggest there is another reason why students' attitude decline a year to year. "*isolation of students as they moved through the grades. As the number of opportunities for student-student and student-teacher interactions, both academic and social, declined, negative attitudes towards science increased*".

In general, attitudes towards the sciences fall with age but, in the study by Skryabina in Scotland from age 10-20, she found that the decline was not observed at all stages. In simple terms, she found positive attitudes at primary school stages, a very rapid decline from ages 12-14, then, for those who continue on, a rapid growth in positive attitudes towards physics from ages 14-16, followed by a slight decline after that (Reid and Skryabina, 2002a). They were able to relate the moves in attitudes very precisely to specific aspects of the curriculum.

One of the great problems is that teachers are often asked to teach outside their area of specialism with pupils aged 12-14. Teachers whose major subject is another science discipline will not know how biology relates to our lives as well as biology teachers may do and this might be the reason of erosion of science when students go to primary school to junior and high school. This erosion seems to be observed worldwide whenever science subjects are being taught by one teacher.

(c) Gender and attitude towards science

Gardner (1975) points "*Sex is probably the single most important variable related to pupils attitudes to science*". It is recognized that there is gender difference in attitudes towards science and it appears early in life. There seem to be cultural influences relating to community, family and information from media (Murphy, 1990).

It is well established that, among upper primary and secondary school students, boys tend to have interest in physical science and girls tend to have interest in biology (Clarke, 1972; McGuffin, 1973). Girls prefer content which is related to human activity and is person oriented while boys have a natural interest in how things work (Smithers and Hill, 1987: Qualter, 1993). In Scotland, the gender difference in uptakes in the sciences is lower than many other countries and this is probably related to deliberate attempts to make the subject presentation gender neutral. Nonetheless, even here, boys outnumber girls by 2 to 1 in physics while biology is about the reverse. Chemistry attracts boys and girls approximately equally. However, when a girl does choose physics, she stays with it for the remainder of her school career (Reid and Skryabina, 2002b).

Hutt (1972) suggests that gender difference are genetic. However, boys have better spatial ability than girls have and biology needs this ability very much (MacNab, 1988). This seems to be in contradiction with girls preferring biology.

Harding (1982) concluded individual behaviour and teachers' teaching style are more influential that genetic differences. O'Brien and Porter (1994) suggested that the problem lay with the educators not with the girls. The work of Reid and Skryabina (2002b) would support this and they relate this attitudes.

(d) Attitudes and classroom's climate/ teacher

German (1988) noted that, '*The educational process is a social one in which the learners and the teacher come together in an effort to share meaning concerning the concepts and skills of the curriculum*'. Therefore, it is almost inevitable that students' attitudes towards science are influenced by the teacher's personality, ability in and commitment to the subject and how they encourage, motivate and support the students. This is almost certainly why attitudes fall when teachers of one science discipline are asked to teach another: they cannot generate the commitment and enthusiasm and they simply do not have enough background knowledge and understanding to feel competent and confident. This has been shown to be a very marked effect with primary teachers, especially in topics related to physics (Harlen and Holroyd, 1997).

German (1988) studied the role of classroom environment, instructional methods and learning environment and showed how important these were. Moreover, if the teacher has positive attitude towards for the subject, students tend to develop enthusiasm for science, with high motivation (Haladyna and Shaughnessy, 1982). Thus, teacher quality is one of most important factors to develop students' attitude towards for science. This finding was also shown very strongly by the study of Reid and Skryabina (2002a).

3.12 Conclusions

This chapter has reviewed briefly some of the findings from the literature about attitudes, their definitions and the ways by which they develop. It has been demonstrated that attitudes are very important in that they can influence learners considerably, affecting future learning.

It has to be recognised that school pupils will develop attitudes but there are ways by which the learning experiences can encourage the development of more positive attitudes, attitudes towards what is taught how it is taught and the implications arising from what is taught. However, one of the greatest problems is how to measure attitudes and this is the theme of the next chapter.

Chapter 4

Attitude Measurement

4.1 The Problem of Measurement

Attitudes are hidden and not able to be observed directly. This is not so different knowledge, understanding or other intellectual skills. All these have to be inferred from indirect measurements, usually by considering answers to written tests. The approach to attitudes is essentially the same: questions have to be asked either in written or oral form. Thus, attitude measurement relies on the analysis of responses to written surveys or interviews. There is always uncertainty about whether the actual attitude held is being measured. However, this is no different from a test of biology. The mark gained is supposed to be a reflection of ability in biology but the candidate might have had a 'good day' in terms of the questions being asked or their clarity of thought at the time.

Measuring attitudes can give many problems because different researchers may hold different views or definitions of what attitudes are. Furthermore, it could be said that the outcomes of the measurement might define the attitude itself (Reid and Johnstone, 1981). Rickwood (1984) warns that if there are a variety of opinions over nature of attitude, it is not easy to produce a clear conceptual base. Therefore, measurement of attitude is very important and "*must be able to offer accurate and valid picture of learner attitudes to some specific aspect of the learning in the science subject.*" (Reid, 2006).

Many years ago, Cook and Selltiz (1964) divided the techniques of attitude measurement into five types which are shown below;

(1) Self report (questionnaire)
(2) Observation of overt behaviour
(3) Partially structured stimuli (akin and projective tests)
(4) Performance of tasks (congenial material learned rapidly)
(5) Physiological tests

These five approaches could be categorised in two ways: *Direct* approaches and *Indirect* approaches. The direct approach is a way which involves contacting people directly, for example using questionnaire and interviews. The indirect approach is the way which is deducing data from a set of indirect observations. The latter one usually takes much time to consider and it is easy to have misinterpretation. Therefore, most researchers use the direct approach in science education and they can collect large number of responses from students in a reasonably short time.

Bill (1973) strongly supports using questionnaire techniques rather than interviews because it is easier than interview, "*even with young adolescents of poor intellectual ability*." Moreover, he thinks the interview has poor reliability and its data analysis would be difficult even though it might be a useful technique.

4.2 Questionnaires

> "*The questionnaire is an important instrument of research, a tool for data collection.... It can be considered as a set of questions arranged in a certain order and constructed according specially selected rules. The questionnaire has a job to do; its function is measurement*"
>
> (Oppenheim, 1992, p.100)

There are two types of questions in a questionnaire: *Open* and *Closed* ones. An open question does not have any choices to tick for students and the answer will come from their own words or ideas. This way offers two large advantages: such questions are easy to ask and also there is freedom for the responder (Oppenheim, 1992, p. 112). However, the very openness may make it difficult and time consuming to answer and such questions are often very difficult to analyse because of the potential wide range of answers. Closed question may be more difficult to set but they are easier and quicker to answer and analyse. The problem is to ensure clarity and lack of ambiguity while offering the respondents a wide enough range of answers to cover what they think. This can lead to problems if the respondent does not find an answer which express his/her view and, of course, there is no freedom to generate other answers.

There are two main solutions to avoid confusion when the researcher collects data. First of all, the content of the questionnaire should be clear or easy to recognise what a researcher would like to know for each question. This is essential to deduce students' attitudes which are hidden from direct observation. For example, when the researcher would like to know students attitudes in biology classes, the questionnaire might include questions which relate to: teachers, laboratory classes, outdoor activities, classroom's atmosphere etc. Secondly, a questionnaire should use appropriate techniques which can reflect the evaluative character of students' attitude. However, there are some problems for each solution and these are described below.

There are numerous problems which can arise in using questionnaires but most of these can be reduced with care. The problems can be related to questionnaire design, to questionnaire use and to questionnaire analysis. Each is discussed in turn and related to the validity and reliability of such questionnaires (which will be discussed later).

In planning a questionnaire, the researcher needs to have a clear idea what attitudes are being explored. It is useful to develop a check list of the key ideas. Questions have to be developed and these need to be clear and avoid ambiguities. The nature of the attitudes under consideration may well determine the type of questions to be asked and there are several well tested formats available and these will be outlined later. Having developed a set of questions, these must be matched against the check list to see if there is adequate coverage. It is helpful for the questions to be examined critically by other researchers or by teachers who know the pupils who will be tested. This usually allows for the removal of inappropriate questions and for ensuring lack of ambiguities. It also makes it more likely that questions which are appropriate to the pupils are being asked, reflecting their language, thought forms and covering the types of issues of relevance to them.

Reid (1978) argues for the use of pre-testing to check design and clarity of the questionnaire while Solomon (1949) considers that it is the only way to avoid possible complications. Ideally, pre-testing involves a good sample reflecting the type of population for which the questionnaire was designed. However, pre-testing with small samples followed by discussion can also be very useful. Nonetheless, pre-testing is not always possible.

When the questionnaire is used, the conditions must be good. The instructions should be clear, the timing should be adequate and the pupils must be very aware that their responses will not affect their marks or their relationship to their teacher. Of course, the pupils may still not answer honestly but the written and spoken instructions can encourage total honesty and confidentiality. Samples selected should be large and reflect the population under consideration. However, it is still possible that responses will reflect what the pupils would like the situation to be rather than what it actually is. This has been described as the 'reality-aspiration' problem (Danili, 2004) but interviewing can often reveal if this is happening.

This chapter seeks to offer a brief but critical overview of the main approaches adopted and to outline the procedures chosen for this study.

4.3 Thurstone's Method

Thurstone (1929) broke fresh ground in the measurement of attitudes. It was believed that it is impossible and, indeed, futile to try to measure people's attitude before he developed a method which involved the following steps.

(1) Collect a wide range of statements (about 100-150) related to attitude under consideration.
(2) Edit them down to about 40-60 statements from previous ones seeking that each statement should have validity, with the range covering a wide range of opinion and including neutral position.
(3) Find around 300 people who can give opinions relating to the attitude under consideration.
(4) The 300 were each asked to divide these statement into 11 categories: from extremely positive to extremely negative including neutral. The aim was that the interval between each category should be equal.
(5) Select those statements where the 300 were in agreement. This gave about 20 statements.
(6) Respondents were asked to pick those statements with which they agree. Their score was the sum of the category values of the statements chosen.

Although extremely demanding of time and needing many people to make it work, this approach by Thurstone opened the door and demonstrated that attitude measurement was a possibility. A few years later, Likert (1932) considered Thurstone's approach and he developed another approach which avoided the cumbersome collecting of statements and time consuming use of judges.

Today, the Thurstone method is rarely used. However, Ramsden (1998) does discuss a clever approach which has employed some of the Thurstone ideas. They state that it is possible to add evaluations from separate questions, "*if there is some evidence that the marks are on a comparable scale, measure something meaningful and giving a total which carries some clear meaning*". However, this is quite rare case and it should be care if there are some rich detail arising from each question which is lost when scores are combined.

However, the main impact of Thurstone was that it led to other attempts to measure attitudes. The method of Likert (1932) is discussed below.

4.4 Likert's Method

Likert's method can be considered one of the most popular nowadays and his method avoids the use of judges and is relatively easy to develop and use.

A set of statements (perhaps about 40) are gathered relating to the attitude under consideration. Respondents are asked to consider each statement and express their view often on a five point scale: from 'strongly agree' to strongly disagree'. Their responses are correlated and those questions which correlate best with each other are selected (perhaps abut 20) and used to measure the attitude under consideration.

An example (Reid, 2003) illustrates the approach although it did not use the selection by correlation:

Think about your experiences in laboratory work in chemistry.

Tick the box which best reflects your opinion.	*Strongly Agree*	*Agree*	*Neutral*	*Disagree*	*Strongly Disagree*
(a) I believe that the laboratory is a vital part in learning chemistry	☐	☐	☐	☐	☐
(b) I prefer to have written instructions for experiments	☐	☐	☐	☐	☐
(c) I was unsure about what was expected of me in writing up my experiment	☐	☐	☐	☐	☐
(d) Laboratory work helps my understanding of chemistry topics	☐	☐	☐	☐	☐
(e) Discussions in the laboratory enhance my understanding	☐	☐	☐	☐	☐
(f) I only understood the experiment when I started to write about it afterwards	☐	☐	☐	☐	☐
(g) I had few opportunities to plan my experiments	☐	☐	☐	☐	☐
(h) I felt confident in carrying out the experiments in chemistry.	☐	☐	☐	☐	☐
(i) I found writing up about experiments pointless	☐	☐	☐	☐	☐
(j) The experimental procedure was clearly explained in the instructions given	☐	☐	☐	☐	☐
(k) I was so confused in the laboratory that I ended up following the instructions without understanding what I was doing	☐	☐	☐	☐	☐

Likert gives respondents' responses five-point scale from strongly agree to strongly disagree including neutral one. Respondents tick one of the five positions provided. He allocates a scoring system (assuming all the questions are positive) as follows:

strongly agree = 5
agree = 4
neutral = 3
disagree = 2
strongly disagree = 1

The respondent's attitude is found by adding up the scores obtained. Likert method is brilliant and ingenious but it makes many assumptions and the scoring method is open to much criticism (Reid, 2006). Pearson correlation assumes an approximation to normality which frequently is not observed. It assumes that five points on one question is equivalent to five points on another. It implies that an 'agree' is worth twice as a 'disagree'. Indeed, it takes ordinal numbers and assumes they have ratio meaning. Reid (2006) has shown how two respondents can obtain the identical score with completely different attitude profiles.

There is another problem. When he measured people's attitude, he used sums of scores which were given for each box: for example the rating "strongly agree" has 5 point and the rating "strongly disagree" has 1 point. According to his approach in summing up scores, the maximum possible score could mean extremely positive attitude and the minimum score could mean extremely negative attitude. However, this can be criticised because this final score is obtained by summing up scores from evaluation of different items which may have different meanings:

> "*To add up the weight, the number of doors, the number of cylinders in a motor car to produce a single number would have little meaning* "
>
> (Gardner, 1975)

The problem is that a method devised for use in psychology research has been used uncritically in educational research. Here, internal consistency (indicated by good correlations between the questions) is often not desirable. In addition, attitudes in the area of education are highly multifaceted (see Gardner, 1995) and this approach hides much of the interesting and rich detail. Reid (2006) observes how many such attitude scales have been developed in science education and how little they have revealed which has been useful to inform science educators. He argues that this is simply because this approach is '*incapable'* of offering the key insights as the important detail is lost in final scores.

There are two important principles relating to attitude measurement (Reid, 2006). Firstly, it is not possible with current methods to measure an attitude in any absolute sense. All that can be done is make comparisons between two different groups (often using a statistic like chi-square). Secondly, the attitudes of an individual cannot be measured with any degree of certainty. However, the patterns of attitudes for large groups can be measured and Reid (2003) has shown that this can be achieved with very high levels of reliability.

4.5 Osgood's Method

Osgood was exploring semantic meaning (Osgood *et al*., 1957) and developed a very simple test for that purpose. He asked the respondents to think of some idea and then tick boxes placed between adjectival pairs of words (or adjectival phrases). They carried out extensive factor analyses on the data obtained to look for underlying structures which might offer insights into semantic meaning. They found consistently that the factor analyses came up with three factors, one of which they labelled as 'attitude'. They developed an approach which might be useful for attitude measurement.

Osgood (1967) called his method the semantic-differential method and this is now one of the most popular and useful methods. Heise (1970) demonstrated that " *Osgood's method is eminently suitable in terms of type of sample, administration, easy design, high reliability and validity when compared to other methods*"

The method originally had a seven-point rating scale and gives two adjective words at the ends of a scale. Respondents ticked one box on each line. Later, Heise (1970) modified from seven-point scale to four or five-point one to '*yield adequate reliability for most purposes'*. There is another advantage that it takes a shorter time to answer questions than with the Likert approach because it is easy to do. It has even found found useful for young children (Reid, 1978).

A modern day example (quoted in Reid, 2003) illustrates their approach:

What are your opinions about University Physics?
Place a tick in one box between each phrase to show your opinions.

I feel I am coping well	☐	☐	☐	☐	☐	☐	I feel I am not coping well
I am not enjoying the subject	☐	☐	☐	☐	☐	☐	I am enjoying the subject
I have found the subject easy	☐	☐	☐	☐	☐	☐	I found the subject hard
I am growing intellectually	☐	☐	☐	☐	☐	☐	I am not growing intellectually
I am not obtaining new skills	☐	☐	☐	☐	☐	☐	I am obtaining new skills
I am enjoying practical work	☐	☐	☐	☐	☐	☐	I am not enjoying practical work
I am getting worse at the subject	☐	☐	☐	☐	☐	☐	I am getting better at the subject
It is definitely 'my' subject	☐	☐	☐	☐	☐	☐	I am wasting my time in this subject

Some of the questions are positive to the left and others are positive to the right.

In the original scoring method, scores were allocated from the positive end: 6,5,4,3,2,1 for the six boxes. The respondent's attitude was found by adding up their scores for the questions. However, the scoring method has all the same problems as that used originally by Likert (1932). In the example shown above, each line was analysed on its own and the dubious scoring method was not used by the original researcher (Shah, 2004). This offered considerable detail about the university student's views of their laboratory experiences and pin-pointed the key issues to be addressed.

Overall, the approach works well, is fast for respondents and has the advantage over Likert that both ends of each scale are defined. It offers considerable detail and the approach should be seen as complementary to that developed by Likert.

4.6 Rating questions

In rating questions, the respondent is offered a set of responses and asked to place them in some kind of order or to pick a small number of greatest significance against some criterion (Reid, 2003). The intention is to make deductions about the attitude held, based on the ordering of the responses. The questions are sometimes difficult to set but can be quite revealing. An example illustrates the approach:

Tebogo has been studying global warming and wonders how scientists know what is actually the truth about global warming. Her friends suggest several ways to find the answers. These are listed in the shaded box.

A	Read Scientific books
B	Talk to experts like University professors
C	Carry out experiments to test the idea of global warming
D	Collect as much information as possible about global warming
E	Assume global warming is true and act accordingly
F	Use intelligent guesswork
G	Look at information which has already been gathered through research
H	Accept what majority of people believe is true about global warming

Arrange these suggested answers in order of their importance by placing the letters A, B, C...etc. in the boxes below. The letter which comes first is the <u>most</u> important and the letter which comes last is the least important for you.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Most important Least important

This question was used with Botswanian school pupils and was related to a large study looking at young people's attitudes towards the gathering of scientific evidence. Where the pupils placed options B, C and G was analysed, these bring considered as the most important pointers to a scientific way of thinking (Reid and Serumola, 2006).

There are other variants on this. Here is another example (Reid, 2003)

Here are several reasons why laboratory work is part of most chemistry courses
Place a tick against the THREE reasons which YOU think are the most important.

Chemistry is a practical subject	☐
Experiments illustrate theory for me	☐
New discoveries are made by means of experiments	☐
Experiments allow me to find out about how materials behave	☐
Experiments teach me chemistry	☐
Experimental skills can be gained in the laboratory	☐
Experiments assist me to planning and organise	☐
Experimental work allows me to think about chemistry	☐
Experimental work makes chemistry more enjoyable for me	☐
Laboratory work allows me to test out ideas	☐

4.7 Scoring methods

The problems associated with scoring have been raised already and the whole area was reviewed recently in relation to science education by Reid (2006). Based on the idea that good correlations indicate the likelihood that questions are measuring the same underlying variable, psychologists use a technique of adding up scores on the questions to gain a total score which is supposed to reflect a measure of the variable under question. This approach has been used uncritically in science education but it fails to offer the kind of insights simply because the attitude variables are so multifaceted.

For example, if a questionnaire is to offer useful insights for biology teachers, the teachers want to know the details of which specific views or beliefs are held towards specific aspects of the whole process of learning biology. Adding scores loses this important detail.

Figure 4.1 illustrates the problem in adding up scores. This fictional figure shows that two students responding to five questions with five points for response. These two students respond completely oppositely but gain the same total score. Thus, similar scores may be obtained for very different patterns of attitudes. Therefore, when for science educators would like to explore learner attitudes in order to identify the aspects which need attention, adding up scores is certainly meaningless.

	Strongly agree	***Agree***	***Neutral***	***Disagree***	***Strongly disagree***
Score	1	2	3	4	5
Question 1	○				×
Question 2		○		×	
Question 3			○×		
Question 4		×		○	
Question 5	×				○

Figure 4.1 Two students' responses (imaginary)

(x - indicates the choices of student A while O indicates the choices of student B. 'Total' score of each is 15.)

There is a further problem in adding up scores. There is no way of knowing if the ordinal scales are equally spaced and there is no way of knowing if a score on one question is equivalent to a score on another in terms of its value in reflecting the attitude under question (Reid, 2006). Of course, ticking boxes on, say, a five point scale gives a very high level of potential individual error. It is always surprising that many researchers quote means and standard deviations (of ordinal data, often not normally distributed!) to two decimal places given the 'softness' of the original responses. This is why large samples are needed when the data reliability becomes very robust and reproducible (see Reid, 2006).

4.8 Reliability and Validity

Questionnaires should be designed which are *reliable* and *valid*. In other words, the results are reproducible and the questionnaire is testing what it is intended to test (Oppenheim, 1992). Gardner (1975) and Schibeci (1984), have offered many criticism about the reliability and validity of attitude assessments and German (1988) has noted that,

> *"Attitude research must clearly define the construct being investigated, describe the place of this construct within a large theoretical framework of relevant variables, and demonstrate the reliability and validity of instruments used to measure it"*

The reliability of any measurement is essentially the confidence the researcher has that the measuring device will give the same or similar results on more than one equivalent occasion. However, reliability has often been defined in terms of internal consistency and is a measure of the extent to which all the test items are measuring the same kind of thing. This is rarely important or even desirable in education. Statistical techniques like inter item correlations, Cronbach's alpha or split half reliability have been used as estimates of internal consistency. In attitude measures in relation to education, where the attitudes are very multifaceted, such approaches are inappropriate.

The more fundamental question is the extent to which the outcomes from a questionnaire given on a Tuesday one week would be similar to those obtained the same day the next week. Reid (2006) quotes evidence to show the conditions under which this kind of test: re-test reliability can be expected to be very high. These include details of the careful construction of the questionnaire, its use under clear and satisfactory conditions and the use of large samples which reflect the population under study.

There are many ways to have high quality validity: develop questions with discussions with the population concerned (Skyrabina, 2000; Bennett *et al*, 2001), check questions with colleagues, pre-test questions where possible (Friel, 1976; Skryabina, 2000), try to do some sample interviews (e.g. Skryabina 2000; Shah, 2004). It is impossible to be certain of validity. Ideally, it can be estimated by looking at some completely separate measurement. However, this is often not possible. The key is to be cautious in drawing conclusions.

4.9 Method used in this Study

This study aims to explore the kinds of attitudes in relation to their studies in biology which are to be found with Japanese school pupils aged 12-15. The goal is to look for any trends with age as well as consider gender differences. As many aspects of their learning experiences in biology as possible will be explored. The methods of Likert, Osgood and rating questions will all be used. The doubtful approach of scaling will be avoided. Large samples will be sought to give increased confidence in reliability. The data obtained will be interpreted in the light of several years experience in teaching this age group but care will be taken not to assume that all the responses of the pupils will be totally valid. Ideally, interviewing would be an advantage in considering the validity of the questions but travel made this an impossibility.

To illustrate the approach, some examples of the questions used are offered here.

One question aimed to explore how the pupils evaluated themselves in relation to their experiences in learning biology. This question was derived from the successful question used by Skryabina in her parallel study in physics (Skryabina, 2000) where interviewing was possible to validate some of the items.

Think about ***yourself*** as you study biology
Use one tick for each line

It is definitely not my subject	☐	☐	☐	☐	☐	☐	It is definitely my subject
I am not growing intellectually	☐	☐	☐	☐	☐	☐	I am growing intellectually
I am getting worse in the subject	☐	☐	☐	☐	☐	☐	I am getting better in the subject
I feel I am not coping well	☐	☐	☐	☐	☐	☐	I feel I am coping well
I do not want to learn more about biology	☐	☐	☐	☐	☐	☐	I want to learn more about biology

Another question explored a whole range of separate issues to see how the students evaluated their experiences.

Please show your opinion by ***ticking one box on each line***

		Strongly Agree ↓	*agree*	*Neutral* ↓	*disagree*	*Strongly Disagree* ↓
(a)	It is essential that every pupil learns some biology	☐	☐	☐	☐	☐
(b)	I should like to study more science (biology) in high school or university	☐	☐	☐	☐	☐
(c)	Using a textbook is more useful when you study than using your notebook.	☐	☐	☐	☐	☐
(d)	Biology is a subject to be memorised	☐	☐	☐	☐	☐
(e)	Knowledge of biology is useful in making world decisions	☐	☐	☐	☐	☐
(f)	Doing an examination in biology is stressful	☐	☐	☐	☐	☐
(g)	Biology is related my life	☐	☐	☐	☐	☐
(h)	Biology is useful for my career	☐	☐	☐	☐	☐

Another example used the rating approach where the factors which attracted them towards biology were considered. This aimed to ask the question about what influences were important in developing positive attitudes and, in a sense, is seeking for some kind of reason for the developed attitudes.

Many things may have helped you to become interested in biology
Please tick the two which are most important to you.

☐ Scientific TV programs	☐ My parents
☐ Biology lessons	☐ Literature
☐ Exhibitions, demonstrations, festivals	☐ My teacher
☐ My friends	☐ Other (please indicate):

Chapter 5

Survey of Pupil Attitudes in Japan

5.1 Introduction

There are some concerns about 'less strenuous' education which the Japanese government has introduced (see Chapter 2). It is possible that this is a factor in the declining interests in science. There are many surveys about mathematics and physics related to this problem but nothing has been carried to consider biology.

Two typical Japanese private schools are surveyed for this study. In Japan (especially in Tokyo), private schools are very common and the ones chosen for this study reflect a typical cross section of the population.The sample size of both schools is shown below (Table 5.1).

Samples Used			
	Boys	***Girls***	***Total***
Grade 3	185	121	310
Grade 4	228	185	422
Grade 5	253	181	438
Grade 6	79	21	100
Totals	**745**	**508**	**1270**

Table 5.1 Samples Used
※There are 17 students who did not indicate gender

In order to gain an overall picture of the views of students from grade 3 to grade 6 (ages 14-18), the students were invited to complete a survey. The aim in this was not only to gain an overview but to see how student attitudes changed and developed over these grades as well as looking to see if there were any major difference in the attitudes of boys and girls. It is typical for more girls to be attracted towards biology. This survey offered an opportunity to see where the differences lay in attitudes relating to biology.

The survey was applied in November (the school years starts in April) and the survey took 10-15 minutes to complete. It was made clear to the students that their responses to the survey would not be seen by their teachers and that they would not affect their school test results in any way. In this way, it was hoped that the students would answer honestly and that the picture obtained would be accurate.

Before the questionnaires was constructed, the main areas of interest were listed. Questions were then devised and subjected to careful scrutiny by experienced teachers. Minor changes were incorporated and the whole questionnaire was translated into Japanese and the translation checked. The questionnaires were used with large samples under appropriate conditions and it is hoped that the reliability would be good (see Reid, 2003). Because the questionnaire was considered by experienced teachers, it is hoped that the questions are valid. The questionnaire is now shown in full (in English).

Thinking About Biology

We want to find out what you think of biology.
Please answer every question as honestly as you can!
Your answer will not affect your school marks in any way.
We hope that what you tell us will help those who are learning biology
Biology is the part of science which looks at animals (including humans) and plants.

About Yourself

Are you ☐ Girl ☐ Boy *(Tick one box)*
Your grade ....

Here is a way to describe a racing car:

quick	☑	☐	☐	☐	☐	☐	slow
important	☐	☐	☑	☐	☐	☐	unimportant
safe	☐	☐	☐	☐	☑	☐	dangerous

The positions of the ticks between the word pairs show that you consider it as very quick, slightly more important than unimportant and quite dangerous.

Use this method to answer some of the questions below.

About your studies in biology

(1) Think about your ***classes*** where you have ***studied biology*** (perhaps as part of science).
Use the method shown above to say how you found these classes.
Use one tick for each line

I do not enjoy these lessons	☐	☐	☐	☐	☐	☐	I enjoy these lessons
The lessons are interesting	☐	☐	☐	☐	☐	☐	The lessons are boring
I find biology is difficult	☐	☐	☐	☐	☐	☐	I find biology is easy
I hate these lessons	☐	☐	☐	☐	☐	☐	I like these lessons
I learn nothing new in science (biology) lessons	☐	☐	☐	☐	☐	☐	I learn much new in science (biology) lessons
I am not obtaining new skills	☐	☐	☐	☐	☐	☐	I am obtaining a lot of new skills
Science (biology) is important subject	☐	☐	☐	☐	☐	☐	Science (biology) is unimportant subject
The teacher makes me less interested in biology	☐	☐	☐	☐	☐	☐	The teacher makes me more interested in biology

(2) Think about ***yourself*** as you study biology
Use the method shown above to describe yourself
Use one tick for each line

It is definitely not my subject	☐	☐	☐	☐	☐	☐	It is definitely my subject
I am not growing intellectually	☐	☐	☐	☐	☐	☐	I am growing intellectually
I am getting worse in the subject	☐	☐	☐	☐	☐	☐	I am getting better in the subject
I feel I am not coping well	☐	☐	☐	☐	☐	☐	I feel I am coping well
I do not want to learn more about biology	☐	☐	☐	☐	☐	☐	I want to learn more about biology

(3) ***If you have not used laboratories in your science classes, go to question 4.***
Think about your work in ***laboratories***.
Use the method shown above to describe how you found the laboratories
Use one tick for each line

I do not enjoy practical laboratory work	☐	☐	☐	☐	☐	☐	I do enjoy practical laboratory work
Laboratory lessons are interesting	☐	☐	☐	☐	☐	☐	Laboratory lessons are boring
The laboratory class is difficult	☐	☐	☐	☐	☐	☐	The laboratory class is easy
I hate laboratory classes	☐	☐	☐	☐	☐	☐	I like laboratory classes
I learn nothing new	☐	☐	☐	☐	☐	☐	I learn much new in science (biology) lessons
I am not obtaining new skills	☐	☐	☐	☐	☐	☐	I am obtaining a lot of new skills
Laboratory classes are unimportant	☐	☐	☐	☐	☐	☐	Laboratory classes is important
It is the worst part of biology	☐	☐	☐	☐	☐	☐	It is the best part of biology

(4) Please show your opinion by ***ticking one box on each line***

		Strongly Agree	*Agree*	*Neutral*	*Disagree*	*Strongly Disagree*
(a)	It is essential that every pupil learns some biology	☐	☐	☐	☐	☐
(b)	I should like to study more science (biology) in high school or university	☐	☐	☐	☐	☐
(c)	Using a textbook is more useful when you study than using your notebook.	☐	☐	☐	☐	☐
(d)	Biology is a subject to be memorised	☐	☐	☐	☐	☐
(e)	Knowledge of biology is useful to making world decision	☐	☐	☐	☐	☐
(f)	Doing an examination in biology is stressful	☐	☐	☐	☐	☐
(g)	Biology is related in my life	☐	☐	☐	☐	☐
(h)	Biology is useful for my career	☐	☐	☐	☐	☐

(5) What do you enjoy most in your Biology lessons?
Please tick the three which you enjoy most.

- ☐ Studying biology application in life
- ☐ Doing practical work
- ☐ Explaining natural phenomena
- ☐ Studying how biology can improve my life
- ☐ Preparing for career
- ☐ Learning about modern discoveries in biology
- ☐ Studying about the human body
- ☐ Studying how biology can help me in life
- ☐ Studying about biology applications in social life
- ☐ Studying how biology can make our lives healthier
- ☐ Understanding modern developments in biology
- ☐ Studying about environment problems and how to solve them
- ☐ Other: (please say what): ....

(6) Many things may have helped you to become interested in biology
Please tick the two which are most important to you.

- ☐ Scientific TV programs
- ☐ Biology lessons
- ☐ Exhibitions, demonstrations, festivals
- ☐ My friends
- ☐ My parents
- ☐ Literature
- ☐ My teacher
- ☐ Other (please indicate):
  ....
  ....

(7) What would like most like to be in the future
Please tick one box

- ☐ a pro-baseball/football player
- ☐ a game programer
- ☐ an officer
- ☐ a comic writer or illustrator
- ☐ a teacher
- ☐ a researcher
- ☐ a scientist
- ☐ an engineer
- ☐ an entertainer
- ☐ something else: ....
- ☐ a doctor/a nurse/an animal doctor/a pharmacist
- ☐ a hairdresser
- ☐ a lawyer/a judge/a prosecutor
- ☐ a counsellor

(8) Which school subject is the best for helping you to get a job when you leave school?
Please tick three boxes

☐ English	☐ Japanese	☐ Ethics
☐ Geography	☐ Mathematics	☐ Science
☐ Craft and design	☐ Music	☐ History
☐ Politics/Economy/Civics	☐ Art	☐ Computing
	☐ Health and physical education	

(9) To be a Biologist is likely to be:
Tick as many as you like

☐ Interesting	☐ Stressful	☐ Not bad	☐ Hard
☐ High status	☐ Popular	☐ Enjoyable	☐ Stupid
☐ Well paid	☐ Fun	☐ Prestigious	☐ Easy to get job

(10) Would you say that knowledge of biology makes your life more interesting?

☐ Yes ☐ No ☐ I have no idea

5.2 Analysing the Data

The responses for each part of each question for all 1270 students were entered into a spreadsheet. This showed the grade group and gender and allowed for these groups to be separated easily. The frequencies for each grade group were found using SPSS and the frequencies for boys and girls were found the same way.

The patterns of results for each part of each question are discussed. However, there is no certainty that the results reflect any absolute measurement of attitudes. It was, therefore, more important to compare the grade groups to look for trends in the responses, such trends being interpreted in the light of the school situation, the syllabus and the teaching approaches used.

To compare the patterns of responses, chi-square was used as a contingency test. The chi-square statistic is one of the most common way to analyse non-parametric data. There are two ways of using chi-square tests.

Goodness of Fit Test: This is used when an experimental group is to be compared to a control group. In this study, there is no control group and this application of the statistic cannot be used.

Contingency Test: This method does not have any control group but the expected frequencies are estimated using both of the groups. It is widely used in gender studies when clearly there can be no control group. It was also used in this study to compare the response patterns from the various grade groups. The details of the calculation are shown in the appendix. The chi-Square Test can have problems if the frequency in any category falls too low. To avoid this data are grouped and the degrees of freedom drop accordingly. A category limit of 5% or 10% (whichever is more critical) was used here. Chi-square as a contingency test can only be calculated using frequencies. For clarity, the data are presented in the tables as percentages but all the calculations have been carried out using frequencies. A summary of the use of chi-square is in the appendix.

The two schools had different organisation structures and time allocations:

Grade	Arts	Science
3	4	4
4	2	2
5	1	2
6	0	2

School 1

Grade	Arts	Science
3	4	4
4	0	0
5	0	2
6	0	1

School 2

Table 5.2 Number of hours of biology classes per week at the two schools

- ☆ at grade 3, the time is for General Science (biology, chemistry, physics and geology)
- ☆ at grade 4, the time is for General Science (biology and geology)
- ☆ at grade 5 and 6, the time is for Biology

The data from the survey has given sets of frequencies of responses from four year groups. The overall aim is to see how attitudes related to biology have developed and changed over their educational journey from about age 12-16.

Firstly, it has to be noted that the year 6 group is different in that, at that stage, they have the opportunity to opt into biology while the younger age groups contain the whole population. Comparisons involving year 6 must be made, therefore, with caution. Indeed, the application of the survey to year 6 was an added bonus in a study which was focussing mainly on the Junior High School experience in Biology.

It is possible to carry out a 6 by 4 contingency chi-square test using all four sets of data. This would show any general trend of change with time. If there is a steady trend of change in a question, then this would be a good way forward in this study. Unfortunately, even a superficial inspection of the frequency data obtained here show that there is often no clear trend of change: views can move in one direction from one year to the next, followed by a move in another in a subsequent year comparison. Therefore, this approach leads to a chi-square value which can be difficult to interpret.

Another approach which has been used extensively in previous studies is to carry out several chi-square comparisons with pairs of year groups. There are, potentially, six such comparisons. This approach leads to several chi-square values but each is easier to interpret and relate to trends in the teaching and learning process, comparing one year group with another. The approach adopted here is to compare successive year groups (3 and 4; 4 and 5; 5 and 6) and then compare years 3 and 5 as these are the first and final years of the three year Junior High School experience when all follow the same course.

An analysis of question 1 is shown in the appendix using both approaches. This illustrates how the first method is more difficult to interpret when there is no consistent trend from year to year across all four year groups. However, having a single chi-square value is attractive and the method used in this study is open to possible type 1 errors. As a result of this, conclusions are drawn with appropriate caution.

Question 1

This question explores aspects of how they see their classes where they have studied biology.

1(a)	I do not enjoy these lessons					(%)	Comparison	$\chi 2$	df	p
Grade 3	7	6	18	28	21	20	*Grade 3 and 4*	18.6	5	< 0.001
Grade 4	8	12	16	33	20	11	*Grade 4 and 5*	19.5	5	< 0.01
Grade 5	15	14	20	22	19	11	*Grade 5 and 6*	17.8	4	< 0.01
Grade 6	14	4	14	32	13	23	*Grade 3 and 5*	33.4	5	< 0.001

Table 5.3 Data Question 1(a)

From grade 3 to grade 5, enjoyment drops, with some increase in enjoyment in grade 6. However, in grade 6, there is some polarisation of views, with some being very positive and others being very negative.

Moving from grade 3 to 4, their biological study becomes more academic and the textbook includes more difficult contents and technical words. In grades 3-5, there are those who will leave biology at the end of grade 5. Thus, grade 6 includes only those more committed to science although quite a number will not need biology for university entrance.

1(b)	The lessons are interesting					(%)	Comparison	$\chi 2$	df	p
Grade 3	15	18	30	25	10	3	*Grade 3 and 4*	6.0	4	ns
Grade 4	11	20	30	21	9	9	*Grade 4 and 5*	13.2	5	< 0.05
Grade 5	15	21	28	13	12	12	*Grade 5 and 6*	5.7	5	ns
Grade 6	16	14	30	19	7	13	*Grade 3 and 5*	24.5	4	< 0.001

Table 5.4 Data Question 1(b)

The majority of students in all grades are interested in biology but gradually the number of students who are not interested tends to increase although the increase stops after grade 5. Grade 6 students think it is important to prepare for the entrance examination for university. This might involve biology or it might not, leading to some polarisation of view.

1(c)	I find biology is difficult				(%)	Comparison	χ2	df	p
Grade 3	12	17	28	26	9	7	***Grade 3 and 4***	5.7	4	ns
Grade 4	18	18	27	25	9	4	***Grade 4 and 5***	17.2	4	< 0.01
Grade 5	26	23	24	17	7	4	***Grade 5 and 6***	7.9	4	ns
Grade 6	25	12	27	25	1	9	***Grade 3 and 5***	33.5	4	< 0.001

Table 5.5 Data Question 1(c)

Many students think biology is difficult in all grades. The proportion finding it difficult rises from grades 3 to 5 (columns 1 and 2) and the proportion seeing it as easy falls from grades 3 to 5 (columns 5 and 6). Again grade 6 see a very slight improvement, and it is a very similar pattern as seen in the other questions.

There is some kind of repetition in learn biology moving from grade 4 to grade 5 because they learn general science before. However, the content becomes more complex. However, it can look the same as before but it is more difficult for them. There are many technical words which they have to memorised and built on to previous knowledge.

At grade 6, some students need biology for entrance examination for university. Therefore, they start to learn biology by themselves actively more than before. As a result, they begin to accumulate knowledge and also understand biology better. This might be connected wuth the observation that some grade 6 students think biology is easy.

1(d)	I hate these lessons				(%)	Comparison	χ2	df	p
Grade 3	6	6	19	37	17	15	***Grade 3 and 4***	10.9	5	ns
Grade 4	9	9	20	33	19	10	***Grade 4 and 5***	14.3	5	< 0.05
Grade 5	15	11	22	25	15	12	***Grade 5 and 6***	2.4	4	ns
Grade 6	13	7	23	29	18	10	***Grade 3 and 5***	31.4	5	< 0.001

Table 5.6 Data Question 1(d)

While the majority of students do not hate biology lessons, the proportion who do (columns 1 and 2) rises from grade 3 to 5 and then, again, improves in grade 6. This is almost inevitable as the courses steadily become more demanding, with the improvement for grade 6 because the students are now more committed. However, students views are fairly widely spread out.

1(e)	I learn nothing new					(%)	Comparison	χ^2	df	p
Grade 3	3	4	13	37	23	21	*Grade 3 and 4*	5.2	4	ns
Grade 4	6	5	10	34	25	22	*Grade 4 and 5*	24.0	4	< 0.001
Grade 5	9	7	15	23	21	25	*Grade 5 and 6*	5.5	4	ns
Grade 6	12	4	9	32	21	21	*Grade 3 and 5*	28.9	4	< 0.001

Table 5.7 Data Question 1(e)

Many students think they learn something new through their biology classes through all grades.

1(f)	I am not obtaining new skills					(%)	Comparison	χ^2	df	p
Grade 3	5	6	18	37	19	14	*Grade 3 and 4*	0.5	5	ns
Grade 4	6	7	18	36	18	15	*Grade 4 and 5*	10.0	5	ns
Grade 5	10	8	18	29	19	16	*Grade 5 and 6*	2.1	5	ns
Grade 6	9	5	17	29	19	20	*Grade 3 and 5*	10.1	5	ns

Table 5.8 Data Question 1(f)

Student opinion spread widely all grades although the majority see themselves as learning new skills, with no significant changes from grade to grade.

1(g)	Science (biology) is important subjec					(%)	Comparison	χ^2	df	p
Grade 3	13	13	32	24	13	5	*Grade 3 and 4*	4.0	4	ns
Grade 4	12	18	32	21	11	6	*Grade 4 and 5*	16.8	5	< 0.01
Grade 5	12	15	28	21	10	14	*Grade 5 and 6*	7.3	5	ns
Grade 6	19	18	29	16	10	7	*Grade 3 and 5*	6.0	4	ns

Table 5.9 Data Question 1(g)

Views are fairly spread out but the majority of students think biology is an important subject. Grade 5 shows a slight fall off in the positive view. By grade 5, those who are thinking of choosing to leave biology are clearer in their minds about possible choices.

1(h)	The teacher makes me less interested (%)						Comparison	χ^2	df	p
Grade 3	5	6	18	38	17	17	*Grade 3 and 4*	16.6	5	< 0.01
Grade 4	12	7	19	39	13	11	*Grade 4 and 5*	6.9	5	ns
Grade 5	9	6	22	36	17	10	*Grade 5 and 6*	6.1	4	ns
Grade 6	11	2	20	39	10	17	*Grade 3 and 5*	10.2	5	ns

Table 5.10 Data Question 1(h)

In general, the pupils tend to think that their teacher does not make them less interested in biology. There are some slight fluctuations but the grade groups tend to hold fairly constant views. The role of the teacher was founds to be very important in the study by Skryabina in physics (see Reid and Skryabina, 2002a). It is highly likely that the teacher role is also important in biology although the strength of the influence is uncertain.

Some Conclusions

Looking at how they see their biology classes, there is much that is positive. The broadly tendency is to enjoy them, see them as interesting and likeable but views become significantly (but not to a huge extent) more negative with grade. They tend to see biology as difficult and this grows with grade.

In general, at all ages, most think they are learning new things, obtaining new skills while they do appreciate that biology is important. The role of the teacher is seen by many as important in this.

Question 2

This question asks them to think about themselves as they study biology.

2(a)	It is definitely not my subject				(%)	Comparison	χ2	df	p
Grade 3	12	6	31	30	11	9	*Grade 3 and 4*	10.6	5	ns
Grade 4	16	10	23	32	10	8	*Grade 4 and 5*	34.9	5	< 0.001
Grade 5	30	16	18	22	8	7	*Grade 5 and 6*	10.0	5	ns
Grade 6	44	9	13	17	8	9	*Grade 3 and 5*	61.3	5	< 0.001

Table 5.11 Data Question 2(a)

Students, who have not had strong opinions towards for biology (the middle two columns), gradually have decided biology is definitely not their subject from grade 3 to grade 6. On the other hand, the proportion of students who consider biology is their subject (final two columns) is stable through all grades. As they progress through school, the students start to see which subjects are most suitable for them. By grade 6, many students have already decided what kind of university they would like to go or what job they want to have and significant numbers will realise that this is not biology.

2(b)	I am not growing intellectually				(%)	Comparison	χ2	df	p
Grade 3	7	6	26	39	17	6	*Grade 3 and 4*	2.4	5	ns
Grade 4	9	8	26	38	15	5	*Grade 4 and 5*	15.1	4	< 0.01
Grade 5	14	13	26	30	11	7	*Grade 5 and 6*	1.6	5	ns
Grade 6	17	10	23	31	10	8	*Grade 3 and 5*	25.9	5	< 0.001

Table 5.12 Data Question 2(b)

As the groups become older, more of them tend to move from neutral positions to see themselves as not growing intellectually. This is a worrying feature. Of course, it may simply reflect that students are turning away from biology as other subjects hold more attraction. However, it does suggest that they find something lacking in their studies in biology although this may simply mean lack of effort on their part.

2(c)	I am getting worse in the subject				(%)	Comparison	χ2	df	p
Grade 3	7	5	23	40	21	5	*Grade 3 and 4*	5.2	4	ns
Grade 4	7	9	23	38	18	4	*Grade 4 and 5*	19.6	4	< 0.001
Grade 5	14	14	25	29	12	7	*Grade 5 and 6*	5.4	5	ns
Grade 6	21	14	17	32	10	6	*Grade 3 and 5*	39.7	5	< 0.001

Table 5.13 Data Question 2(c)

The pattern of moves with age is very similar to that observed in question 2(b) and probably for the same reasons.

2(d)	I feel I am not coping well					(%)	Comparison	χ2	df	p
Grade 3	6	5	24	38	19	8	***Grade 3 and 4***	12.2	4	< 0.05
Grade 4	8	10	26	34	16	6	***Grade 4 and 5***	23.4	5	< 0.001
Grade 5	15	17	24	26	12	6	***Grade 5 and 6***	3.9	5	ns
Grade 6	21	14	22	27	8	7	***Grade 3 and 5***	55.2	5	< 0.001

Table 5.14 Data Question 2(d)

At the beginning in grade 3, students think they can cope reasonable well but this becomes less positive grade by grade until very few feel they are coping well by grade 6. Of course, the course in biology becomes steadily more demanding and more complex grade by grade. Nonetheless, it might be expected that they would cope as well as they mature and gain more knowledge and experience.

2(e)	I do not want to learn more about biology					(%)	Comparison	χ2	df	p
Grade 3	6	5	18	40	22	9	***Grade 3 and 4***	10.7	5	ns
Grade 4	8	10	20	33	19	11	***Grade 4 and 5***	23.5	5	< 0.001
Grade 5	17	9	23	26	13	12	***Grade 5 and 6***	2.3	5	ns
Grade 6	19	11	19	30	10	10	***Grade 3 and 5***	47.5	5	< 0.001

Table 5.15 Data Question 2(e)

As with questions 2(d) and 2(e), the students have become negative with age. Is this because they see biology as irrelevant to their lives and lifestyles or is it simply that then course is too difficult? Perhaps, the attraction of other subjects is pulling some away.

Summary

Views in relation to how they see themselves in learning biology, while quite positive, all get worse with age. There is tendency for the students to hold rather neutral views, especially with the younger two grades. However, in very general terms, they are not too unhappy about how they are coping, feeling that they are not getting better or worse and not sure about whether they are growing intellectually. As might be expected, as their career directions become clearer with age, there are increasing numbers who do not see biology as ‘their’ subject and they tend not to want to study it further.

Question 3

Think about your work in ***laboratories***.

I do not enjoy practical laboratory work	☐	☐	☐	☐	☐	☐	I do enjoy practical laboratory work
Laboratory lessons are interesting	☐	☐	☐	☐	☐	☐	Laboratory lessons are boring
The laboratory class is difficult	☐	☐	☐	☐	☐	☐	The laboratory class is easy
I hate laboratory classes	☐	☐	☐	☐	☐	☐	I like laboratory classes
I am not obtaining new skills	☐	☐	☐	☐	☐	☐	I am obtaining a lot of new skills
Laboratory classes are unimportant subject	☐	☐	☐	☐	☐	☐	Laboratory classes is important subject
It is the worst part of biology	☐	☐	☐	☐	☐	☐	the best part of biology

3(a)	I do not enjoy practical laboratory work					(%)	Comparison	$\chi 2$	df	p
Grade 3	3	7	13	27	21	29	***Grade 3 and 4***	7.0	4.0	ns
Grade 4	10	7	10	22	22	30	***Grade 4 and 5***	1.1	5	ns
Grade 5	11	8	9	20	21	31	***Grade 5 and 6***	3.0	4	ns
Grade 6	14	2	13	16	18	37	***Grade 3 and 5***	13.1	4	< 0.05

Table 5.16 Data Question 3(a)

Their enjoyment of laboratory work does not change much with age. In general, they like this or are neutral in their views. Previous research has shown that laboratory work is liked by many pupils (Shah, 2004) and the result here are consistent with this.

3(b)	Laboratory lessons are interesting					(%)	Comparison	$\chi 2$	df	p
Grade 3	23	16	26	23	9	4	***Grade 3 and 4***	8.9	4	ns
Grade 4	25	23	24	14	7	8	***Grade 4 and 5***	5.6	5	ns
Grade 5	26	18	22	16	6	13	***Grade 5 and 6***	1.7	5	ns
Grade 6	33	16	20	15	5	11	***Grade 3 and 5***	8.6	4	ns

Table 5.17 Data Question 3(b)

Many students are interested in laboratory classes through all grades. The laboratory work may prove interesting because there are many specimens, sample and small animals in formalin and students like study at such unusual situations.

3(c)	The laboratory class is difficult					(%)	Comparison	$\chi 2$	df	p
Grade 3	6	11	33	31	12	7	***Grade 3 and 4***	8.1	5	ns
Grade 4	13	11	28	30	10	9	***Grade 4 and 5***	2.5	5	ns
Grade 5	12	11	32	25	11	8	***Grade 5 and 6***	3.7	4	ns
Grade 6	13	4	34	33	8	9	***Grade 3 and 5***	7.4	5	ns

Table 5.18 Data Question 3(c)

The response patterns for all grade groups show an approximately normal distribution. This suggests that the difficulty level of laboratory classes is about right. Laboratory work may be difficult because of complex equipment or procedures; however, most laboratory classes have clear instructions and, if students understand what they should do before experimental class, they might not think laboratory work difficult.

3(d)	I hate laboratory classes				(%)	Comparison	χ^2	df	p
Grade 3	4	5	14	35	19	22	*Grade 3 and 4*	6.1	4	ns
Grade 4	9	4	11	29	23	25	*Grade 4 and 5*	10.0	4	< 0.05
Grade 5	12	6	15	25	16	27	*Grade 5 and 6*	0.8	4	ns
Grade 6	13	3	13	25	14	31	*Grade 3 and 5*	15.5	4	< 0.01

Table 5.19 Data Question 3(d)

Although there are minor differences between grade groups, the general pattern is that the pupils hold a positive attitude towards laboratory classes, consistent with the other questions.

3(e)	I learn nothing new				(%)	Comparison	χ^2	df	p
Grade 3	2	5	19	35	22	17	*Grade 3 and 4*	7.1	4	ns
Grade 4	9	4	14	32	22	20	*Grade 4 and 5*	2.7	4	ns
Grade 5	11	5	15	30	18	21	*Grade 5 and 6*	0.8	4	ns
Grade 6	12	3	19	27	16	23	*Grade 3 and 5*	13.5	4	< 0.01

Table 5.20 Data Question 3(e)

The majority of students think they can learn something new in laboratory classes through all grades. However, there is some polarisation of views at grade 5 and 6. In much laboratory work, the students are merely confirming what they have been taught or what they have been taught is being illustrated. Nonetheless, seeing it for themselves may be perceived as new.

3(f)	I am not obtaining new skills				(%)	Comparison	χ^2	df	p
Grade 3	4	5	18	35	24	14	*Grade 3 and 4*	8.0	4	ns
Grade 4	8	7	16	32	19	18	*Grade 4 and 5*	7.1	5	ns
Grade 5	11	5	22	32	15	16	*Grade 5 and 6*	5.2	4	ns
Grade 6	11	3	20	33	9	25	*Grade 3 and 5*	14.8	4	< 0.01

Table 5.21 Data Question 3(f)

All grades students tend to believe that they can have new skill through experimental class or hold fairly neutral opinions. The opinion has slight polarisation from grade 5 while some grade 6 students strongly think they can have something new. It is likely that the word ‘skill’ is seen as a practical skill and this can only really be learned in a laboratory.

3(g)	Laboratory classes are unimportant (%)						Comparison	$\chi 2$	df	p
Grade 3	4	4	13	34	24	21	***Grade 3 and 4***	4.8	4	ns
Grade 4	9	4	11	32	21	23	***Grade 4 and 5***	6.1	4	ns
Grade 5	11	7	14	25	20	23	***Grade 5 and 6***	3.2	4	ns
Grade 6	9	3	13	26	19	30	***Grade 3 and 5***	16.0	4	< 0.01

Table 5.22 Data Question 3(g)

A high proportion of students of all grades agree with laboratory classes are important although quite a number hold fairly neutral views. Even students, who would not use biology for their future's job and entrance examination for university, think experiment work is important.

3(h)	It is the worst part of biology (%)						Comparison	$\chi 2$	df	p
Grade 3	4	2	17	39	24	14	***Grade 3 and 4***	12.4	5	< 0.05
Grade 4	7	2	11	41	19	21	***Grade 4 and 5***	15.7	4	< 0.01
Grade 5	8	4	18	28	17	25	***Grade 5 and 6***	7.2	5	ns
Grade 6	8	0	13	29	24	26	***Grade 3 and 5***	24.5	4	< 0.001

Table 5.23 Data Question 3(h)

The majority of students think laboratory classes are the best part of biology through all grades, this tending to increase year by year. Moreover, the number of students who hold a negative view is very low. Part of this may be genuine enjoyment of the laboratory class. However, it could simply be that this is better than taking part in a teacher-led presentation.

Summary

Looking at question 3, it is clear that laboratory work in biology tends to be valued and enjoyed by the pupils at all ages, consistent with general findings about science laboratory work. It seems that biology laboratory work in Japan is going reasonably well.

Question 4

This looks at a a variety of issues

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
(a) It is essential that every pupil learn some biology	☐	☐	☐	☐	☐
(b) I should like to study more science (biology) in high school or university	☐	☐	☐	☐	☐
(c) Using textbook is more useful when you study than using your notebook.	☐	☐	☐	☐	☐
(d) Biology is a subject to be memorised	☐	☐	☐	☐	☐
(e) Knowledge of biology is useful to making world decision	☐	☐	☐	☐	☐
(f) Doing an examination in biology is stressful	☐	☐	☐	☐	☐
(g) Biology is related in my life	☐	☐	☐	☐	☐
(h) Biology is useful for my career	☐	☐	☐	☐	☐

4(a)	**Essential that every pupil learn some biology**				**(%)**	**Comparison**	**$\chi 2$**	**df**	**p**
Grade 3	4	42	41	10	4	***Grade 3 and 4***	8.6	3	ns
Grade 4	7	39	34	14	6	***Grade 4 and 5***	22.9	4	< 0.001
Grade 5	7	29	31	21	13	***Grade 5 and 6***	20.5	4	< 0.001
Grade 6	20	30	27	11	12	***Grade 3 and 5***	33.7	3	< 0.001

Table 5.24 Data Question 4(a)

Opinions tend to be fairly neutral although agreement with the question is chosen more than disagreement. As they proceed through the school, some will realise that they do not need biology for their chosen future study and this causes an increasing rejection of biology as a subject for all. Some students in grade 5 might think learning biology is just a 'tool' for entrance examination for university; therefore, if they do not use it, they do not think students need to learn biology. However, in general, biology is easy to connect to to the lives of students and this helps to make it be seen as relevant for all.

4(b)	**... more biology in high school or university**				**(%)**	**Comparison**	**$\chi 2$**	**df**	**p**
Grade 3	7	30	43	14	6	***Grade 3 and 4***	16.8	4	< 0.01
Grade 4	10	30	30	21	9	***Grade 4 and 5***	27.2	4	< 0.001
Grade 5	7	21	31	21	20	***Grade 5 and 6***	3.5	4	ns
Grade 6	11	20	35	15	20	***Grade 3 and 5***	42.4	4	< 0.001

Table 5.25 Data Question 4(b)

In general, views are widely spread and move around a bit from grade to grade. However, looking at the first two columns, it can be seen that those wanting more biology tend to fall in number.However, the responses are reasonably positive and between 37% (grade 3) and 28% (grade 5) seeming to be wanting more.

4(c)	Textbook...more usuful...than .. notebook			(%)	Comparison	χ2	df	p
Grade 3	7	12	29	40	11	***Grade 3 and 4***	23.5	4	< 0.001
Grade 4	11	21	34	27	8	***Grade 4 and 5***	30.5	4	< 0.001
Grade 5	5	12	33	36	15	***Grade 5 and 6***	15.9	4	< 0.01
Grade 6	8	21	40	17	14	***Grade 3 and 5***	3.6	4	ns

Table 5.26 Data Question 4(c)

There are some quite big differences between grade groups but no clear trend overall. These may simply reflect differences in the way classes run in successive grade groups. However, notebooks are regarded as more useful than textbooks in general.

4(d)	Biology is a subject to be memorised			(%)	Comparison	χ2	df	p
Grade 3	17	39	30	11	2	***Grade 3 and 4***	1.3	3	ns
Grade 4	18	43	27	11	2	***Grade 4 and 5***	11.1	3	< 0.05
Grade 5	26	37	22	9	6	***Grade 5 and 6***	11.8	4	< 0.05
Grade 6	16	29	31	14	10	***Grade 3 and 5***	11.8	3	< 0.05

Table 5.27 Data Question 4(d)

It is said that such a large number of students consider biology to be a subject to be memorised, the proportion increasing from grade 3 to 5. The more committed group of grade 6 shows a slight improvement. If the examinations reward the recall of information, words and facts, then this will strongly control how the pupils see their learning. However, it is much less easy to pass entrance examination for university just memorising biological words and grade 6 students might realise it.

4(e)	Biology is useful in making world decisions			(%)	Comparison	χ2	df	p
Grade 3	16	43	32	8	1	***Grade 3 and 4***	7.1	3	ns
Grade 4	18	51	24	4	3	***Grade 4 and 5***	7.1	3	ns
Grade 5	19	43	27	6	5	***Grade 5 and 6***	6.7	3	ns
Grade 6	28	31	31	1	9	***Grade 3 and 5***	2.3	3	ns

Table 5.28 Data Question 4(e)

All grades of students agree that knowledge of biology is useful to think about global issue and the proportion has not changed. This is encouraging in that the student can see something of the significance of biology in terms of the some of the major issues at a world level.

4(f)	Doing an examination in biology is stressful				(%)	Comparison	χ2	df	p
Grade 3	7	8	44	30	11	*Grade 3 and 4*	10.0	4	< 0.05
Grade 4	10	13	37	32	9	*Grade 4 and 5*	9.9	4	< 0.05
Grade 5	13	15	37	24	12	*Grade 5 and 6*	3.6	4	ns
Grade 6	13	13	46	17	13	*Grade 3 and 5*	19.0	4	< 0.001

Table 5.29 Data Question 4(f)

To take an examination is usually stressful but there are so many regular examination a year that students must be used to facing them. However, if they fail regular examination in high school (from grade 4), they cannot be promoted to the next grade and this is likely to produce stress.

4(g)	Biology is related in my life				(%)	Comparison	χ2	df	p
Grade 3	7	30	40	17	6	*Grade 3 and 4*	4.6	4	ns
Grade 4	8	33	35	15	9	*Grade 4 and 5*	6.0	4	ns
Grade 5	9	30	31	17	13	*Grade 5 and 6*	5.5	4	ns
Grade 6	15	26	35	10	14	*Grade 3 and 5*	14.5	4	< 0.01

Table 5.30 Data Question 4(g)

The response patterns are well spread although skewed towards agreement. It is surprising that the students do not hold very strongly views of positive agreement. However, they all have bodies and human life is very much influenced by the life cycles of animals and plants. Perhaps, they see the question as the biology they are taught as directly related to their day to day lives.

4(h)	Biology is useful for my career				(%)	Comparison	χ2	df	p
Grade 3	4	14	46	22	14	*Grade 3 and 4*	6.2	3	ns
Grade 4	9	15	38	22	17	*Grade 4 and 5*	16.2	4	< 0.01
Grade 5	6	11	34	24	26	*Grade 5 and 6*	2.5	4	ns
Grade 6	8	11	37	25	19	*Grade 3 and 5*	19.8	3	< 0.001

Table 5.31 Data Question 4(h)

Views tend to be neutral or negative. Looking at careers and university entrance, the need for biology is limited to a small range of specific areas, including medicine and related medical subjects. However, even here, physics and chemistry hold important roles. Other subjects, like mathematics and the physical sciences often open more doors in terms of career opportunities in that biology can often build on these very successfully.

Summary

In general, the students see the importance of biology but this tend to fall with age. Similarly, biology as a useful subject in career terms also falls with age although the students do not rate it highly in career terms. These patterns are caused by the students becoming more career conscious with age and, inevitably, seeing more that biology is not so essential for their future possible studies.

It is surprising that the relationship of biology to life is not stronger but this perhaps reflects the syllabus being followed or a lack of teacher emphasis. It is a matter of concern that so many see biology as a subject to be memorised and this grows stronger with age. It is likely that an examination system which rewards recall is causing this.

Students do seem to appreciate the importance of biology in terms of the decisions of life. They prefer their own notebooks as a means of learning. Not surprisingly, they find biology examinations fairly stressful and this grows with age.

Question 5

What do you enjoy most in your Biology lessons?
*Please tick the **three** which you enjoy most.*

Grade 3	*Grade 4*	*Grade 5*	*Grade 6*	*Average*	
18	22	20	24	**20**	Studying biology application in life
47	36	40	43	**41**	Doing practical work
32	31	37	27	**33**	Explaining natural phenomena
11	14	8	10	**11**	Studying how biology can improve my life
11	9	10	8	**10**	Preparing for career
20	13	14	19	**16**	Leaning about modern discoveries in biology
27	34	41	36	**35**	Studying about the human body
29	30	25	22	**27**	Studying how biology can help me in life
15	16	19	21	**17**	Studying about biology applications in social life
23	25	22	21	**23**	Studying how biology can make our lives healthier
23	17	11	18	**16**	Understanding modern developments in biology
36	31	27	32	**31**	Studying about environment problems and how to solve them
					Other

Table 5.32 Data Question 5 (%)

As might be expected, doing practical work is rated most highly. They also strongly enjoy learn biology as it makes make sense of the world around them and themselves: natural phenomena and the human body. Environmental issues are also rated highly. Similarly, there is a positive response to biology applying to life, helping in life, and helping to make lives healthier. All of this is consistent with the findings of Skryabina who found that the applications of physics in the context of the lifestyles of students was a powerful factor in generating positive attitudes towards physics (Reid and Skryabina, 2002a).

On the other hand, they do not see how improving their life relates to enjoyment, perhaps implying that they do not have enough information about that in previous biology classes. In addition, enjoyment of biology is not see as relating to the career potential of biology.

Question 6

Many things may have helped you to become interested in biology
*Please tick the **two** which are most important to you.*

Grade 3	*Grade 4*	*Grade 5*	*Grade 6*	*Average*	
50	50	51	56	**51**	Scientific TV programs
46	44	42	34	**43**	Biology lessons
28	26	30	22	**28**	Exhibitions, demonstrations, festivals
8	7	6	6	**7**	My friends
5	6	5	11	**6**	My parents
24	22	18	28	**22**	Literature
24	23	22	21	**23**	My teacher
					Other

Table 5.33 Data Question 6 (%)

In Scotland, Skryabina found that events outside the school teaching situation had little impact in attracting students towards physics (Reid and Skryabina, 2002a). Thus, parents, friends, TV programmes and exhibitions, demonstrations and festivals were of marginal importance. In Japan, with biology, a different pattern is found. While parents and friends have little influence, TV certainly is powerful, while exhibitions, demonstrations and festivals are of importance. This may reflect that biology-based TV programmes are very attractive. They can show the living world dramatically but, by its nature, much biology is easily accessible to those who watch TV while much physics is abstract and much less accessible.

Question 7

What would like most like to be in the future
Please tick ***one*** *box.*

Grade 3	*Grade 4*	*Grade 5*	*Grade 6*	*Average*	
4	4	5	5	**4**	a pro-baseball/ football player
2	1	2	1	**2**	a game programer
10	19	17	15	**16**	civil servant
2	2	1	4	**2**	a comic writer or illustrator
8	6	8	1	**7**	a teacher
3	5	4	8	**4**	a researcher
2	2	2	3	**2**	a scientist
6	5	6	9	**6**	an engineer
5	3	3	9	**4**	an entertainer
14	10	10	4	**11**	doctor/a nurse/an animal doctor/a pharmacist
4	4	3	3	**4**	a hairdresser
6	5	4	7	**5**	a lawyer/ a judge/ a prosecutor
1	2	3	2	**2**	counsellor
					something else

Table 5.34 Data Question 7 (%)

Japanese students appear to be very aware of the professions where job security and reasonable remuneration are likely. The top two choices lie in administration and medicine. while teachers, engineers and the law profession are also attractive. It is interesting to note that, by grade 6, choosing teaching and medicine become very much less attractive. Perhaps the relatively low status of teaching is a problem while the very hard work required for medical careers is becoming apparent.

Question 8

Which school subject is the best for helping you to get a job when you leave school?
*Please tick **three** boxes.*

Grade 3	Grade 4	Grade 5	Grade 6	Average	
61	65	65	72	**65**	English
8	5	8	2	**7**	Geography
13	10	9	4	**10**	Craft and design
27	29	33	21	**29**	Politics/ Economy/ Civics
34	35	30	50	**34**	Japanese
31	31	26	19	**28**	Mathematics
15	8	8	9	**10**	Music
9	6	5	10	**7**	Art
15	14	12	7	**13**	Health and physical education
11	10	10	7	**10**	Ethics
25	24	24	13	**23**	Science
10	12	11	26	**12**	History
24	23	30	23	**26**	Computing

Table 5.35 Data Question 8 (%)

English stands out. Perhaps this reflects the power of the internet or the growing appreciation of the importance of English in so much of science and technology. However, Japanese and mathematics are also considered as very important by all grades of students although mathematics drops in importance with the oldest group.

The importance of politics, economics and civics as well as science and computing are also rated highly. Much of this is consistent with the characteristics of the kinds of careers which are important in Japanese society.

Question 9

To be a Biologist is likely to be:
Tick as many as you like

Grade 3	*Grade 4*	*Grade 5*	*Grade 6*	*Average*	
27	25	23	25	**25**	Interesting
10	8	9	5	**9**	High status
15	17	10	5	**13**	Well paid
19	21	24	23	**22**	Stressful
6	4	3	7	**4**	Popular
24	16	19	15	**19**	Fun
24	18	21	20	**21**	Not bad
22	18	17	22	**19**	Enjoyable
11	10	9	7	**10**	Prestigious
56	54	57	40	**54**	Hard
9	11	12	11	**11**	Stupid
6	6	6	9	**6**	Easy to get job

Table 5.36 Data Question 9 (%)

Students of these ages are unlikely have any accurate picture of what is involved in being a biologist. Therefore the picture painted by the data in table 5.36 will reveal public perceptions as well as misinformation. Indeed, their image of a biologist may simply be their biology teacher although it has to be noted that some will be taught their biology by those trained in physics and chemistry giving an even more distorted picture.

To be a biologist is not regarded as popular while getting a job is seen as difficult and stressful for all grade students. The job is regarded as hard by a majority possibly linked to the way they see school courses as demanding. The job is not seen as of high status. On a positive note, the work is seen as interesting, enjoyable, fun and, generally, not bad.

5.3 Conclusions

There is tendency that students become less interested in biology, with less of a feeling of enjoyment, as they get older. Furthermore, the number of students who do not think they are growing intellectually and do not cope very well, has grown. These results might imply that students are not seeing the connections between biology lessons and their real lives. However, it could be that, as they get older, some are drifting away from interest in biology as they develop other interests for potential careers.

It is a matter of concern if students think biology is just to be memorised. However, this may arise if the rewards from the examinations come from recalling information. According to the survey, few students are interested in biology for future work and many students think to be a biologist is difficult. Perhaps there is a need for the teacher to introduce the variety of jobs which are related to biology and broaden students' horizons.

It depends on schools but in general, it is difficult to have many experimental classes because students have to move from a class room to a science room (usually it takes time), it takes time to prepare for laboratory classes (it is rare science teachers have technicians) and the schedule is very tight to cover all curriculum. Therefore, experimental classes looks something special for students and it is one of the reason why they like laboratory classes. In fact, majority of students love experimental work and enjoy them and therefore should be included as much as possible.

Students tend to be interested in specific topics which are related to themselves such as environmental issues, structure of their body and health. The majority of the students think they can learn something new from biology classes even if they do just memorise what they learn but it is not certain whether they can utilise the knowledge for their life. Again, it is very important for teachers to try to connect what they teach in biology classes and human life and it is good idea using video of science TV programmes which students like and introduce some event such as science festival.

Chapter 6

Gender and Biology

6.1 Introduction

In an earlier study in physics, Reid and Skryabina (2002b) were able to show that girls and boys were equally attracted towards physics topics although different areas of the curriculum were found to be particularly interesting. The question was whether the same pattern would be found for biology. It is often found that the proportions of boys and girls who choose to study biology at school is very far from equal, with girls outnumbering boys considerably. For example in Scotland, 69% of standard grade candidates are girls (see Scottish Qualifications Authority, 2006). The same pattern exists at university level (68% were girls in one large university: Chandi, 2007). In Japanese school, according to experienced teacher, the number of boys and girls who take biology are in similar proportions.

In this study, it is not easy to compare the responses of the boys and girls for each year group on its own because the samples become too small. Instead, all the boys are compared with all the girls, using chi-square as a contingency test. This offers an overall insight into any differences in the perceptions of boys and girls related to biology. The details for total sample are shown below (Table 6.1).

Samples Used			
	Boys	***Girls***	***Total***
Totals	**745**	**508**	**1270**

Table 6.1 Samples Used

※There are 17 students whose gender was not recorded.

6.2 Analyses and Discussion

As before, the data are presented as percentages for clarity but all statistical calculations have been carried out an the actual frequencies. Each part of each question is considered separately and the response patterns of the girls and boys compared using chi-square as a test of contingency.

Question 1

Think about your ***classes*** where you have ***studied biology***.
Use one tick for each line.

1(a)	I do not enjoy these lessons						χ2	df	p
Boys	11	9	19	28	19	14	4.0	5	ns
Girls	9	12	17	28	20	14			
1(b)	**The lessons are interesting**						**χ2**	**df**	**p**
Boys	15	18	30	19	9	9	4.8	5	ns
Girls	12	21	29	19	11	8			
1(c)	**I find biology is difficult**						**χ2**	**df**	**p**
Boys	19	17	27	22	9	6	15.7	4	< 0.01
Girls	21	22	25	23	6	3			
1(d)	**I hate these lessons**						**χ2**	**df**	**p**
Boys	10	8	21	35	14	11	14.7	5	< 0.05
Girls	11	10	20	26	20	12			
1(e)	**I learn nothing new**						**χ2**	**df**	**p**
Boys	7	5	14	31	20	23	6.4	5	ns
Girls	6	5	11	30	25	22			
1(f)	**I am not obtaining new skills**						**χ2**	**df**	**p**
Boys	8	6	19	34	17	15	8.0	5	ns
Girls	6	9	17	32	21	16			
1(g)	**Science (biology) is important subject**						**χ2**	**df**	**p**
Boys	12	15	29	22	10	10	12.8	5	< 0.05
Girls	13	17	33	19	12	5			
1(h)	**The teacher makes me less interested**						**χ2**	**df**	**p**
Boys	10	6	20	37	14	12	6.6	5	ns
Girls	7	5	19	38	17	14			

Table 6.2 Data Question 1 (%)

Looking at biology classes, boys and girls tend to hold similar perceptions in most parts of the question. There are differences between gender and girls tend to think biology is slightly difficult than boys although it can be seen majority of students think biology is difficult. However, it can be also seen girls hold slightly more polarised views relating to hating or liking the subject.

Generally, girls do not like science and mathematics in Japan because they can be seen as masculine subjects. Biology can be thought one of scientific subject. Thus, girls might think biology is difficult as well. On the other hands, some girls are influenced towards subjects by a teacher more than boys. If some girls do not like a teacher, automatically they might do not like the science too.

It might be thought that girls have tendency to choose jobs related to biology. In addition, it might thought that girls could be good at finding something important related biology. Therefore, girls see science (biology) as slightly more important than the boys.

Question 2

Think about ***yourself*** as you study biology
Use the method shown above to describe yourself

2(a)	**It is definitely not my subject**						**χ2**	**df**	**p**
Boys	22	10	21	27	10	9	5.7	5	ns
Girls	21	13	24	26	9	7			
2(b)	**I am not growing intellectually**						**χ2**	**df**	**p**
Boys	11	8	25	37	13	7	7.2	5	ns
Girls	10	11	26	33	15	5			
2(c)	**I am getting worse in the subject**						**χ2**	**df**	**p**
Boys	11	10	23	26	15	5	5.7	5	ns
Girls	9	11	25	33	18	5			
2(d)	**I feel I am not coping well**						**χ2**	**df**	**p**
Boys	11	10	25	32	15	7	6.2	5	ns
Girls	10	14	24	31	15	6			
2(e)	**I do not want to learn more about biology**						**χ2**	**df**	**p**
Boys	11	9	21	32	17	10	0.2	5	ns
Girls	12	9	20	32	17	11			

Table 6.3 Data Question 2 (%)

There are no differences of thinking themselves about studying biology between boys and girls. This itself is interesting suggesting that girls and boys see themselves in relation to biology study in similar ways. This might suggest that biology would be equally attractive to both. Other factors must cause it to be more popular with girls.

Question 3

Think about your work in ***laboratories***.

I do not enjoy practical laboratory work	☐	☐	☐	☐	☐	☐	I do enjoy practical laboratory work
Laboratory lessons are interesting	☐	☐	☐	☐	☐	☐	Laboratory lessons are boring
The laboratory class is difficult	☐	☐	☐	☐	☐	☐	The laboratory class is easy
I hate laboratory classes	☐	☐	☐	☐	☐	☐	I like laboratory classes
I am not obtaining new skills	☐	☐	☐	☐	☐	☐	I am obtaining a lot of new skills
Laboratory classes are unimportant subject	☐	☐	☐	☐	☐	☐	Laboratory classes is important subject
It is the worst part of biology	☐	☐	☐	☐	☐	☐	the best part of biology

3(a)	I do not enjoy practical laboratory work						$\chi 2$	df	p
Boys	8	6	10	25	19	32	8.0	4	ns
Girls	8	9	11	19	24	30			
3(b)	**Laboratory lessons are interesting**						**$\chi 2$**	**df**	**p**
Boys	26	17	25	18	6	8	6.4	4	ns
Girls	23	22	22	16	9	9			
3(c)	**The laboratory class is difficult**						**$\chi 2$**	**df**	**p**
Boys	10	8	31	32	10	9	15.7	5	< 0.01
Girls	11	14	32	25	12	6			
3(d)	**I hate laboratory classes**						**$\chi 2$**	**df**	**p**
Boys	7	4	15	31	18	26	9.8	4	< 0.05
Girls	10	6	11	26	21	25			
3(e)	**I learn nothing new**						**$\chi 2$**	**df**	**p**
Boys	7	4	15	33	20	21	4.8	4	ns
Girls	9	6	17	30	20	19			
3(f)	**I am not obtaining new skills**						**$\chi 2$**	**df**	**p**
Boys	7	5	19	32	18	19	5.5	4	ns
Girls	9	6	19	34	17	14			
3(g)	**Laboratory classes are unimportant**						**$\chi 2$**	**df**	**p**
Boys	7	4	13	30	22	25	3.5	4	ns
Girls	9	6	13	29	22	21			
3(h)	**It is the worst part of biology**						**$\chi 2$**	**df**	**p**
Boys	6	3	15	34	21	22	1.5	4	ns
Girls	7	3	15	36	21	19			

Table 6.4 Data Question 3 (%)

In only two parts do the boys and girls differ in their views and girls tend to think that laboratory work is more difficult and also have a slightly more negative opinion although the majority of students do not hesitate to show a positive view about laboratory work overall.

Question 4

This looks at a a variety of issues

		Strongly Agree	*Agree*	*Neutral*	*Disagree*	*Strongly Disagree*
(a)	It is essential that every pupil learn some biology	☐	☐	☐	☐	☐
(b)	I should like to study more science (biology) in high school or university	☐	☐	☐	☐	☐
(c)	Using textbook is more useful when you study than using your notebook.	☐	☐	☐	☐	☐
(d)	Biology is a subject to be memorised	☐	☐	☐	☐	☐
(e)	Knowledge of biology is useful to making world decision	☐	☐	☐	☐	☐
(f)	Doing an examination in biology is stressful	☐	☐	☐	☐	☐
(g)	Biology is related in my life	☐	☐	☐	☐	☐
(h)	Biology is useful for my career	☐	☐	☐	☐	☐

4(a)	**essential**						**χ2**	**df**	**p**
Boys	8	34	33	16	8	1	9.2	4	ns
Girls	5	38	36	14	6	0			
4(b)	**I should like ... more ... biology in high school or university**						**χ2**	**df**	**p**
Boys	8	28	35	16	12	1	12.8	4	< 0.05
Girls	8	23	33	24	12	0			
4(c)	**Using a textbook...more usuful...than using your notebook**						**χ2**	**df**	**p**
Boys	9	18	35	26	11	1	34.7	4	< 0.001
Girls	5	12	30	41	10	0			
4(d)	**Biology is a subject to be memorised**						**χ2**	**df**	**p**
Boys	21	38	26	10	5	0	3.9	4	ns
Girls	19	41	26	10	3	0			
4(e)	**useful**						**χ2**	**df**	**p**
Boys	20	44	28	5	3	0	5.9	4	ns
Girls	16	47	28	6	3	0			
4(f)	**Doing an examination in biology is stressful**						**χ2**	**df**	**p**
Boys	11	12	41	25	10	0	4.0	4	ns
Girls	10	12	37	30	11	1			
4(g)	**Biology is related in my life**						**χ2**	**df**	**p**
Boys	10	28	37	16	10	1	6.6	4	ns
Girls	7	34	33	17	9	0			
4(h)	**Biology is useful for my career**						**χ2**	**df**	**p**
Boys	7	14	40	21	18	1	7.5	4	ns
Girls	6	11	36	26	21	0			

Table 6.5 Data Question 4 (%)

Boys are slightly more interested in more biology at higher levels of education. While both boys and girls prefer the textbook to using their notebook, the boys are considerably more enthusiastic about the textbook preference. Generally, girls can have good hand writing and drawing pictures which are quite often used in biology class. Beautiful notes encourages girls using it.

In questions 5 to 9, the students were invited to tick one or more options (in question 9, they could tick as many as they wished). The tabled data show the percentages of the students who ticked each option and, where there are larger differences between the boys and the girls, these are highlighted in colour. The total number of ticks does *not* add up to a specified number as not every student ticked the exact number of boxes as indicated.

Question 5

What do you enjoy most in your Biology lessons?
*Please tick the **three** which you enjoy most.*

Boys	*Girls*	*Difference*	*(All data as percentages)*
21	19	**2**	Studying biology application in life
40	41	**-1**	Doing practical work
36	27	**9**	Explaining natural phenomena
10	11	**-1**	Studying how biology can improve my life
9	10	**-1**	Preparing for career
18	13	**5**	Leaning about modern discoveries in biology
31	40	**-9**	Studying about the human body
26	29	**-3**	Studying how biology can help me in life
20	13	**7**	Studying about biology applications in social life
22	24	**-2**	Studying how biology can make our lives healthier
18	14	**4**	Understanding modern developments in biology
32	28	**4**	problems
		0	Other

Table 6.6 Data Question 5 (%)

It could be seen both gender are interested in making sense of the world related themselves and might due to that, they are willing to doing experimental work. In addition, both disagree it is important to learn biology for their career and improving their future using biology. Differences between boys and girls tend to be be small with most responses. However, boys tend to have their eye on outside of them and girls have opposite. Boys find more enjoyment in explaining natural phenomena and biological applications in social life while girls have a stronger focus on the human body.

This question does suggest one aspect where biology may be attracting girls more. If the course does not look out to see how biology applies in the wider world, then perhaps boys are affected most.

Question 6

Many things may have helped you to become interested in biology
*Please tick the **two** which are most important to you.*

Boys	***Girls***	***Difference***	*(All data as percentages)*
51	49	**2**	Scientific TV programs
41	46	**-5**	Biology lessons
28	27	**1**	Exhibitions, demonstrations, festivals
8	5	**3**	My friends
7	4	**3**	My parents
25	16	**9**	Books related to biology
20	25	**-5**	My teacher
		0	Other

Table 6.7 Data Question 6 (%)

Scientific TV programmes and biology lessons are main factors encouraging students interest for both genders. Differences between boys and girls tend to be be small with most responses. However, boys find literature more helpful while girls find the teacher and class lessons more helpful in developing biological interests. Girls choose biology lesson and biology teacher more than boys. These two factor need interaction between people while reading a biology book is more individual. In general, social relationships are more important for girls than boys and Skryabina (Reid and Skrabina, 2002b) noted the greater importance of the teacher in attracting students into physics. The same appears to be true here for biology.

Question 7

What would you like most like to be in the future?
Please tick one box.

Boys	***Girls***	***Difference***	*(All data as percentages)*
7	0	**7**	a pro-baseball/ football player
3	0	**3**	a game programer
18	13	**5**	civil servant
2	2	**0**	a comic writer or illustrator
5	9	**-4**	a teacher
5	3	**2**	a researcher
3	1	**2**	a scientist
8	2	**6**	an engineer
4	4	**0**	an entertainer
10	11	**-1**	animal
2	6	**-4**	a hairdresser
6	4	**2**	a lawyer/ a judge/ a prosecutor
1	4	**-3**	counsellor
		0	something else

Table 6.8 Data Question 7 (%)

Again, differences are small. Being a civil servant or having a medical career offer stability and good employment prospects in Japanese society. Girls seem more willing to do jobs involving human relationships. On the other hand, as might be expected, more boys are interested in becoming involved in sports as well as in being engineers.

Question 8

Which school subject is the best for helping you to get a job when you leave school?
Please tick three boxes.

Boys	***Girls***	***Difference***	*(All data as percentages)*
60	69	-9	English
7	5	2	Geography
10	10	0	Craft and design
32	25	7	Politics/ Economy/ Civics
31	38	-7	Japanese
35	19	16	Mathematics
7	13	-6	Music
6	8	-2	Art
14	12	2	Health and physical education
11	8	3	Ethics
27	18	9	Science
12	11	1	History
25	27	-2	Computing

Table 6.9 Data Question 8 (%)

There are some interesting differences showing in the data in table 6.9. Mathematics and science are clearly seen as more important by the boys while girls rate English more highly than the boys. Similarly, Japanese and music are also rated slightly more highly by the girls while the area of politics and economics finds slightly more favour with the boys.

When boys consider about their job, generally they think it is easy to get job if they have scientific skills. Girls tend to prefer relationships with people (perhaps assuming that these do not occur in the sciences!). Therefore, Japanese and English, as communication tools, are important for them. It is not easy to be a musician but some girls think it is important more than boys. It could be considered there are choices to be a housewife for girls but it is not common to be this for boys in Japan.

Question 9

To be a Biologist is likely to be:
Tick as many as you like.

Boys	***Girls***	***Difference***	*(All data as percentages)*
27	21	**6**	Interesting
7	11	**-4**	High status
12	15	**-3**	Well paid
24	17	**7**	Stressful
5	3	**2**	Popular
20	16	**4**	Fun
24	16	**8**	Not bad
20	17	**3**	Enjoyable
10	8	**2**	Prestigious
50	59	**-9**	Hard
13	7	**6**	Stupid/ trashy/ nothing
7	5	**2**	Easy to get job

Table 6.10 Data Question 9 (%)

In looking at being a biologist, boys consider this more interesting, stressful and, in general, not bad when compared to the girls although they also think the idea more stupid (although this category is not easy to interpret). Girls think that being a biologist will be harder than the boys.

Generally to get a job is hard in Japan and girls are more realistic. Girls, who do not think to be a biologist in the future, might think more seriously to work as biologist thus they think to be a biologist is hard more than boys. However, boy might think they have responsibility to support their family on his income more than girls. Therefore, they think being a biologist is stressful more than girls. Boys might have dream more than girls and it makes them interested in being a biologist such as a teacher and a researcher.

6.3 Some Conclusions

There are few differences of attitude towards for biology classes between boys and girls. However, there is tendency girls think biology is difficult perhaps because biology might be thought a masculine subject. On the other hand, girls think biology is slightly more important than boys because in fact, biology involves study about connection between nature and humans and humans themselves which girls would love to study. Furthermore, the importance of the teacher is greater for girls and, therefore, if a teacher is good for them, they would learn biology actively. Girls are relationship orientated and, to attract girls to biology, it is important to stress in biology classes how biology affects humans and social relationships.

On the other hand, boys tend to see outside of themselves. Thus, to attract boys to biology, it is important to be stress those aspects where there is a major impact of biology on society and the world around. In physics, Reid and Skryabina (2002b) saw this as the mechanics of the ways things work (in contrast to the human dimensions of physics). There is clearly a parallel in biology, outcomes from which can have major significance in the wider world and understanding how the world works. Despite the biology curriculum attracting girls more, boys tend to have more positive attitude towards learning biology and a positive view for being a biologist. This may simply reflect their greater concern over careers and may be true for all subjects.

All of this has considerable implications for the way the curriculum is constructed and biology lessons are organised and delivered in schools as well as the way textbooks are written and the subject is examined in formal examinations. However, the textbook is very important for teachers and students because many students apply for *National Center Test for University Admissions*. This test is based on all contents of the textbook and does not go outside the contents of textbook. Therefore, teachers try to cover all its contents in biology classes even they do not have enough time to introduce it all properly. It is one of the reason that Japanese schools do not have experimental classes to any great extent. Futhermore, these entrance examination influence the style of regular examination in schools. Ther are few questions where students need to write discriptions or draw inferences because it takes too long for busy teachers to mark all of them and sometimes it is difficult to judge if the answer is correct. Moreover, there is a criticism for such questions are not for measuring biological ability but for measuring Japanese descrimination ability.

Chapter 7

Conclusions

7.1 Overview of Project

The school curriculum is a complex matter and the reasons underlying its construction are not always agreed. Some have argued for a curriculum based on modes of thought (eg Whitfield, 1971) while others have shown the power of an applications-led curriculum to stimulate and attract (eg. Reid, 1999). Whatever the model used, biology is usually seen as holding an important place with a contribution to make.

Studying biology is important for several reasons. Such study offers insights into how the world of the living works and enables the young learner to make sense of what is happening in the world around. However, students live in a world where technological and scientific developments are making major changes. Such changes have enormous social and ethical implications and a study of biology is important in giving understanding which will enable future citizens to be equipped to cope with such choices: issues as diverse as human population control, the protection of endangered species, global warming, cloning of humans and the ethical implications of much recent medical developments which have emerged from fundamental biological research.

Moreover, fundamental knowledge and ideas about the human body are also related to biology. Students should know how the immune system works, what kind of disease is critical for their body and what causes problems for their body. Furthermore, students by understanding how organisms work, will begin to appreciate how important biology is in understanding themselves.

If biology is an important part of the school curriculum, then student attitudes towards biology will be important so that they can gain as much as possible from their studies. Social psychology has a very large research literature about attitudes, what they are, how they develop and change and how they can be measured. This study has brought together some of the main findings and accepted a definition of an attitude as a matrix of cognitive, affective and behavioural elements held in long term memory which have an evaluative dimension. The importance of attitudes is that they lead to the development of values and world views and they are strong predictors of behaviour.

Katz (1960) emphasised the purpose of attitudes and this was then summarised by Reid (2003) who simplified this in an educational context by suggesting that attitudes help the learner to make sense of themselves, make sense of the world around them and make sense of relationships. If the learners see biology as enabling them to understand the world around and equipping them for life, then their attitudes towards biology are likely to be positive. If their attitudes towards biology are negative, then future learning may well be greatly hindered.

Research has shown some of the key features of the ways attitudes develop and change. The work of Festinger (1957) has been important and this led eventually to the development of the idea of internal mental interactivity (Reid and Johnstone, 1981) as a useful way forward in education. However, there are numerous practical ways by which positive attitudes toward biology can be encouraged. These will involve quality teaching and teachers who will offer information involving the students' real life. This may make it easy to make sense about how to use the knowledge which students obtain.

In Japan, there has been considerable concern about the standards of education and the feeling that the sciences are losing ground in the eyes of students: the concerns about '*less strenuous education'*. Biology is one of the scientific subjects and there is concern that student views of biology are not so good and there is hope that steps can be taken to improve such attitudes.

Attitudes which get worse do not necessarily lead to falling enrolments in biology classes at school in that the subject may be part of the curriculum where students have no choice. This is true in Japan. However, in Scotland, Skryabina (2000) found that the attitudes towards the sciences fell quite markedly between ages 12-14 (the years of integrated science) but enrolments in physics stayed high for the following course. This was caused by the fact that all student were *required* to take at least one science subject from age 14 and physics has considerable career potential.

7.2 Procedure Adopted

This study is to be seen in the context of the concerns relating to the sciences in Japan. Most previous work has focussed on physics and there is a need to look at biology. The aim was to gain an overview of the position in Japan, looking at the critical years of 14-18, to see how attitudes were changing with age and how boys and girls differed. This study seeks to define the agenda for further study and action as well as offering a comparison with the general findings relating to physics.

Students' attitudes were explored for 1270 Japanese students using questionnaires based largely on Osgood and Likert's methods (see Chapter 4), the students coming from two typical Japanese private junior high schools and high schools. The questionnaire approach allowed the gathering of much data quickly to offer an overview of the situation. The results were entered onto a spreadsheet first before analysing for frequency using SPSS and a program for chi-square developed from previous work. The more common methods of scaling were rejected on grounds that they made assumptions which were not sustainable and did not offer the detailed picture which was required. Instead questions were analysed separately and patterns collated qualitatively.

Using the methods available today, it is impossible to measure an attitude for an individual with any acceptable degree of accuracy. The aim here was to offer a picture of the patterns of attitudes of large samples, to look for trends with age and gender differences, interpreting these in terms of the situation in biology education in Japan.

Two broad areas were explored. Firstly, by looking at changes in the patterns of responses with age, it is possible to see how attitudes are changing as the students progress. In general terms, it was found that interest decreased towards biology year by year. There are two possible reasons for this. As they progress through school, the likely career directions of students become clearer and, inevitably, for many, these will not involve biology. However, it is also clear that students wish what they are being taught to be related to their lifestyle and to the world around which is part of their life. The biology becomes more difficult, more demanding and, also, more academic and unrelated to life and this may be a factor in causing attitudes to become less positive. Therefore, teachers should try to connect students and the biological world in their lives. This is not easy in that the syllabus may not be ideal and it takes time for the teachers to become increasingly aware of the the issues of importance for their students.

The aim of biology courses at school level is not primarily to produce biologists. However, a good biology curriculum should attract some into careers based on biology. To be a biologist is not so attractive for all students because it seems not to have a high status and students seem to see this kind of career as demanding. Furthermore, it is perhaps difficult for these students to imagine being a biologist because they have little opportunity to see those with a biological background except their biology teacher and a doctor or nurse. However, it would be possible to increase students motivation in being a biologist if the teacher could introduce jobs related biology in biology classes.

The second broad area explored was that of gender and biology. In many areas, there are few differences in the views of boys and girls. There are some differences in their motives in studying biology. Boys are more willing to study how biology contributes to society and the world while girls seem to have a stronger interest in more personal issues like learning related to themselves and keeping healthy bodies. It is important that the curriculum is balanced to meet the aspirations of both groups. The place of textbooks is important in that these more or less define what is to be learned for examinations. The gender balance in textbook presentations is thus critical. The examinations focus almost entirely on recall and recognition. It might be thought that this would apply equally to both boys and girls. However, there is a tendency for boys to be less willing to memorise and thus depend more on working things out (Al-Ahmadi, 2007). This may affect performance.

7.3 Strengths and Weakness of the Study

The survey was developed taking into account questions which had been used in previous major surveys. The questionnaire was considered by those who have some expertise in teaching at this level and was applied by professional teachers at both schools. While its validity cannot be assured completely, all reasonable steps were taken to ensure that it was good. It would have been desirable to interview a small sample to check validity but this was not possible.

The number of students is very large and this will help to achieve good reliability. Being drawn from typical schools, the sample did reflect the population under consideration. However, this approach cannot show individual student's attitudes and could not indicate specific student' progress or opinion. Moreover, there is no certainty that the students answered it honestly although there is no evidence that they were not being honest in that their responses made sense in a Japanese context. However, they may well have answered partly in terms of what the would like things to be rather than what they are.

7.4 Implications of Findings

This survey and analysis may offer a useful guide to predict what students need to know in biology classes in Japan at various grades as well as taking gender differences into account. It offers a picture of typical Japanese junior high school and high school students in their views of biology.

There is some evidence that students are more willing to learn biology if they can see how it is related to their life. Some topics are easy to connect with their life, for example, human body and natural phenomena, but some are not. If teachers develop such topics this may contribute to more positive attitude development (see Chapter 3). The survey also shows students are glad to have opportunities to express themselves in many ways. Thus, experimental work and role play seem important. It might be a huge difference if teachers know what students need and can match their teaching in line with this.

It is possible to bring together the findings form the literature and this study to suggest five reasons why learners at school level may show declining interest in the sciences.

	Reasons	Typical References
1	Not seeing the science related to lifestyle of learner	Skryabina, 2000
2	Not bring able to understand	Hussein, 2006
3	Lack of confidence and commitment of teacher (usually due to subject integration)	Harlen and Holroyd, 1997
4	Lack of perceived career benefit	Skryabina, 2000
5	Social tradition and expectation	Widely observed

Table 7.1 Possible Reasons for Declining Attitudes towards the Sciences

7.5 Future Research

This survey was carried out using questionnaires to gain an overview quickly. It would be useful to know *why* students choose the answers for the questions and this could be explored using interviews. The study was only able to look at the attitudes of students from age 15-18. Studies in physics have shown that attitudes towards physics start to develop at quite a young age (eg. Reid and Skryabina, 2002a). There is an opportunity to extend this study to Japanese primary schools and the early years of Junior High Schools.

The study leaves unanswered clear reasons why students choose to study biology. In the Japanese educational system, the greatest need comes from the university entrance examinations. Students do not have the same kind of freedom which is enjoyed by Scottish students at school in opting into and out of subject areas. Future work might explore why students might like to continue learning biology: genuine interest, job requirements or parental expectations?

This study found boys have a slightly more negative attitude towards learning biology. Perhaps the human dimension of biology has slightly less attraction for the boys. More work needs to be carried out to explore this further and to see how a curriculum might be adapted to make other aspects which are more appealing to boys more dominant.

It was found that many students like experimental work and they consider they can get some new skills and enjoy it. However, not all that much experimental work is conducted because of lack of time, lack of support for teachers and curriculum overcrowding. Work needs to be carried out to consider how the experimental work might be enhanced and improve the biology learning experience in Japan.

The situation in Japanese schools makes some desirable developments difficult. The lecture style in biology classes is common and there is limited opportunity to interact with the minds of the students. Classes are often around 30-40 students in a class and there is tight schedule covering all contents which they have to learn. All of this discourages experimental work and moving beyond the content to be memorised. Nonetheless, there is scope for much research in seeing how the learning experience might be broadened using, for instance, group work involving group problem solving, role playing, group-based experimental work, introducing current biological technology and so on.

This study has offered some insights into pupil attitudes in relation to studies in biology in Japan. It is hoped that the findings will be useful in Japanese education but will also indicate areas where much more research is needed.

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Appendices

Thinking About Biology

We wnat to find out what you think of biology.
Please answer every question as honestly as you can!
Your answer will ntom affect your school marks in any way.
We hope that what you tell us will help those who are learning biology
Biology is the part of science which looks at animals (including humans) and plants.

About Yourself

Are you ☐ Girl ☐ Boy *(Tick one box)*
Your grade ....

Here is a way to describe a racing car:

quick	☑	☐	☐	☐	☐	☐	slow
important	☐	☐	☑	☐	☐	☐	unimportant
safe	☐	☐	☐	☐	☑	☐	dangerous

The positions of the ticks between the word pairs show that you consider it as <u>very</u> quick, slightly more important than unimportant and <u>quite</u> dangerous.

Use this method to answer some of the questions below.

About your studies in biology

(1) Think about your ***classes*** where you have ***studied biology*** (perhaps as part of sciecne).
Use the method shown above to say how you found these classes.
Use one tick for each line

I do not enjoy these lessons	☐	☐	☐	☐	☐	☐	I enjoy these lessons
The lessons are interesting	☐	☐	☐	☐	☐	☐	The lessons are boring
I find biology is difficult	☐	☐	☐	☐	☐	☐	I find biology is easy
I hate these lessons	☐	☐	☐	☐	☐	☐	I like these lessons
I learn nothing new	☐	☐	☐	☐	☐	☐	I learn a lot new in science (biology) lessons
I am not obtaining new skills	☐	☐	☐	☐	☐	☐	I am obtaining a lot of new skills
Science (biology) is important subject	☐	☐	☐	☐	☐	☐	Science (biology) is unimportant subject
The teacher makes me less interested in biology	☐	☐	☐	☐	☐	☐	The teacher makes me more interested inbiology

(2) Think about ***yourself*** as you study biology
Use the method shown above to describe yourself
Use one tick for each line

It is definitely not my subject	☐	☐	☐	☐	☐	☐	It is definitely my subject
I am not growing intellectually	☐	☐	☐	☐	☐	☐	I am growing intellectually
I am getting worse in the subject	☐	☐	☐	☐	☐	☐	I am getting better in the subject
I feel I am not coping well	☐	☐	☐	☐	☐	☐	I feel I am coping well
I do not want to learn more about biology	☐	☐	☐	☐	☐	☐	I want to learn more about biology

(3) ***If you have not used laboratories in your science classes, go to question 4.***
Think about your work in ***laboratories***.
Use the method shown above to describe how you found the laboratories
Use one tick for each line

I do not enjoy practical laboratory work	☐	☐	☐	☐	☐	☐	I do enjoy practical laboratory work
Laboratory lessons are interesting	☐	☐	☐	☐	☐	☐	Laboratory lessons are boring
The laboratory class is difficult	☐	☐	☐	☐	☐	☐	The laboratory class is easy
I hate laboratory classes	☐	☐	☐	☐	☐	☐	I like laboratory classes
I learn nothing new	☐	☐	☐	☐	☐	☐	I learn a lot new in science (biology) lessons
I am not obtaining new skills	☐	☐	☐	☐	☐	☐	I am obtaining a lot of new skills
Laboratory classes are unimportant	☐	☐	☐	☐	☐	☐	Laboratory classes is important
It is the worst part of biology	☐	☐	☐	☐	☐	☐	It is the best part of biology

(4) Please show your opinion by ***ticking one box on each line***

	Strongly Agree	*Agree*	*Neutral*	*Disagree*	*Strongly Disagree*
(a) It is essential that every pupil learns some biology	☐	☐	☐	☐	☐
(b) I should like to study more science (biology) in high school or university	☐	☐	☐	☐	☐
(c) Using a textbook is more useful when you study than using your notebook.	☐	☐	☐	☐	☐
(d) Biology is a subject to be memorised	☐	☐	☐	☐	☐
(e) Knowledge of biology is useful making world decisions	☐	☐	☐	☐	☐
(f) Doing an examination in biology is stressful	☐	☐	☐	☐	☐
(g) Biology is related my life	☐	☐	☐	☐	☐
(h) Biology is useful for my career	☐	☐	☐	☐	☐

(5) What do you enjoy most in your Biology lessons?
Please tick the three which you enjoy most.

- ☐ Studying biology application in life
- ☐ Doing practical work
- ☐ Explaining natural phenomena
- ☐ Studying how biology can improve my life
- ☐ Preparing for career
- ☐ Learning about modern discoveries in biology
- ☐ Studying about the human body
- ☐ Studying how biology can help me in life
- ☐ Studying about biology applications in social life
- ☐ Studying how biology can make our lives healthier
- ☐ Understanding modern developments in biology
- ☐ Studying about environment problems and how to solve them
- ☐ Other: (please say what): ....

(6) Many things may have helped you to become interested in biology
Please tick the two which are most important to you.

- ☐ Scientific TV programs
- ☐ Biology lessons
- ☐ Exhibitions, demonstrations, festivals
- ☐ My friends
- ☐ My parents
- ☐ Literature
- ☐ My teacher
- ☐ Other (please indicate): ....

....

(7) What would like most like to be in the future
Please tick one box

- ☐ a pro-baseball/football player
- ☐ a game programer
- ☐ an officer
- ☐ a comic writer or illustrator
- ☐ a teacher
- ☐ a researcher
- ☐ a scientist
- ☐ an engineer
- ☐ an entertainer
- ☐ something else: ....
- ☐ a doctor/a nurse/an animal doctor/a pharmacist
- ☐ a hairdresser
- ☐ a lawyer/a judge/a prosecutor
- ☐ a counselor

(8) Which school subject is the best for helping you to get a job when you leave school?
Please tick three boxes

- ☐ English
- ☐ Geography
- ☐ Craft and design
- ☐ Politics/Economy/Civics
- ☐ Japanese
- ☐ Mathematics
- ☐ Music
- ☐ Art
- ☐ Health and physical education
- ☐ Ethics
- ☐ Science
- ☐ History
- ☐ Computing

(9) To be a Biologist is likely to be:
Tick as many as you like

- ☐ Interesting
- ☐ High status
- ☐ Well paid
- ☐ Stressful
- ☐ Popular
- ☐ Fun
- ☐ Not bad
- ☐ Enjoyable
- ☐ Prestigious
- ☐ Hard
- ☐ Stupid
- ☐ Easy to get job

(10) Would you say that knowledge of biology makes your life more interesting?

☐ Yes ☐ No ☐ I have no idea

Thank you very much for your cooperation

生物の授業に関するアンケート

生物の授業（動物や植物、人の体に関して学ぶ教科）に関して皆さんが
どのような考えを持っているのかアンケートにご協力お願いします。
このアンケートは皆さんの成績に関係することはなく、個人情報も守られますので
率直なご意見をお聞かせ下さい。あなたのご意見が今後生物を勉強する人の助けになります。

あなた自身について　該当する□の中に✓を、また記入欄には適切な言葉を入れてください。

男□　　女□

中学・高校　　　　　　年

答え方の例 :ミッキーマウスについてのあなたの意見

人気がある	☑	□	□	□	□	□	人気がない
かわいい	□	□	☑	□	□	□	かわいくない
存在感がない	□	□	□	□	☑	□	存在感がある

左の表はあなたがミッキーマウスについて「ものすごく人気がある」、「少しかわいい」、「とても存在感がある」と思っていることを表しています。

↑このような感じで□の中に✓を入れて答えて下さい

あなたが思う生物の授業について

(1)　あなたが今まで受けた生物の授業を思い浮かべてください。生物の授業を受けていない人は、科学の授業の中の生物の範囲（理科第２分野、理科総合B）の授業を考えてください。上記の「答え方の例」を参考に、全ての質問事項の □の中にひとつずつ✓を入れてください。

生物の授業は楽しくない	□	□	□	□	□	□	生物の授業は楽しい
生物の授業には興味しんしんだ	□	□	□	□	□	□	生物の授業は退屈だ
生物の授業は難しい	□	□	□	□	□	□	生物の授業は簡単だ
生物の授業が嫌いだ	□	□	□	□	□	□	生物の授業が好きだ
生物の授業で自分にとって新しいことは学べない	□	□	□	□	□	□	生物の授業で多くの新しいことを学べる
生物の授業によって新しい能力は備わらないと思う	□	□	□	□	□	□	生物の授業によって新しい能力が備わると思う
生物は重要な教科だ	□	□	□	□	□	□	生物は重要ではない教科だ
先生が生物をつまらなくさせていると思う	□	□	□	□	□	□	先生が生物を興味深いものにさせていると思う

(2)　生物の授業(理科第２分野、理科総合B)を受けているあなた自身について思い浮かべて下さい。上記の「答え方の例」を参考に、全ての質問事項の□の中にひとつずつ✓を入れてください。

生物は「自分の」教科ではない	□	□	□	□	□	□	生物は「自分の」教科である
一般的な教養は身についてきていないと思う	□	□	□	□	□	□	一般的な教養が身についてきていると思う
生物に関しての教養は身についてきていないと思う	□	□	□	□	□	□	生物に関しての教養が身についてきていると思う
しっかり学ぶことができていないと思う	□	□	□	□	□	□	しっかり学ぶことができていると思う
これ以上生物を学びたくないと思う	□	□	□	□	□	□	生物をもっと学びたいと思う

(３)　生物（理科第２分野、理科総合B）での実験の時間を思い浮かべて下さい。上記の「答え方の例」を参考に、全ての質問事項の□の中にひとつずつ✓を入れてください。

実験の時間は楽しくない	□	□	□	□	□	□	実験の時間は楽しい
実験の授業は興味しんしんだ	□	□	□	□	□	□	実験の授業は退屈だ
実験の授業は難しく感じる	□	□	□	□	□	□	実験の授業は簡単に感じる
実験の授業が嫌いだ	□	□	□	□	□	□	実験の授業が好きだ
実験の授業で自分にとって新しいことは学べない	□	□	□	□	□	□	実験の授業で多くの新しいことを学べる
実験の授業によって新しい能力は備わらないと思う	□	□	□	□	□	□	実験の授業によって新しい能力は備わると思う
実験の授業は重要ではない	□	□	□	□	□	□	実験の授業は重要だ
実験の時間は生物の授業の中で最悪な時間である	□	□	□	□	□	□	実験の時間は生物の授業の中で最高の時間である

(4)　全ての質問事項の□の中にひとつずつ✓を入れて下さい。

	とてもそう思う	そう思う	どちらでもない	そう思わない	まったくそう思わない
(a)　生物を学ぶことは必要なことだと思う	☐	☐	☐	☐	☐
(b)　高校（大学、専門学校）でも生物に関しての知識を得たいと思う	☐	☐	☐	☐	☐
(c)　教科書よりも自分のノートの方が勉強するのに便利だ	☐	☐	☐	☐	☐
(d)　生物は暗記科目だ	☐	☐	☐	☐	☐
(e)　地球規模での問題を考えるときに生物に関しての知識は必要だ	☐	☐	☐	☐	☐
(f)　生物の試験を受けることはストレスだ	☐	☐	☐	☐	☐
(g)　生物は自分の生活に関係していると思う	☐	☐	☐	☐	☐
(h)　生物は自分の将来のキャリアに関係すると思う	☐	☐	☐	☐	☐

(5)　生物の授業で何を学ぶことがあなたにとって楽しいと思いますか？３つ選んで□の中に✓を入れて下さい。

☐ 生物がどう生活の中に応用してされているのか学ぶこと
☐ 実験をすること
☐ 自然現象を説明すること
☐ 生物学がどう私たちの生活を発展させてきたか知ること
☐ 将来の自分のキャリアに関連することを学ぶこと
☐ 最新の生物学的発見について学ぶこと
☐ 人の体の構造について学ぶこと
☐ 私たちの生活に生物がどう役立っているのか学ぶこと
☐ 生物がどう社会の中に応用されているのか学ぶこと
☐ どう健康を維持できるのか学ぶこと
☐ 最新の生物学の発展について学ぶこと
☐ 環境問題やその解決法について学ぶこと
☐その他（具体的に教えてください）: ....

(6)　何があなたの生物に関しての興味をひきつけていると思いますか？２つ選んで□の中に✓を入れて下さい。

☐　生物に関するテレビ／ビデオ
☐　生物の授業の内容
☐　科学博物館／生物に関するイベント
☐　友達
☐　両親
☐　生物に関する本
☐　生物の先生
☐　その他（内容を書いて下さい）

....

....

(7)　将来どの職業に一番なりたいと思いますか？下の中から１つだけ選んで□の中に✓を入れて下さい。

☐　野球選手／サッカー選手
☐　ゲームプログラマー
☐　公務員
☐　漫画家／イラストレーター
☐　先生
☐　研究者
☐　科学者
☐　技術者／エンジニア／整備士
☐　芸能人
☐　その他（内容を書いてください）: ....
☐　医者／看護士／薬剤師／獣医
☐　美容師
☐　法律家（弁護士／裁判官／検察官）
☐　カウンセラー

(8)　どの教科が卒業後、あなたの仕事に必要になってくると思いますか？３つ選んで□の中に✓を入れて下さい。

☐　英語
☐　地理
☐　技術／家庭科
☐　政経／公民
☐　国語
☐　数学
☐　音楽
☐　美術
☐　保健／体育
☐　倫理
☐　理科（物理／化学／生物）
☐　歴史
☐　情報

(9)　生物に関係のある職業（教師、研究者等）に就くことに対するあなたのイメージは？いくつでも選んで□の中に✓を入れて下さい。

☐　興味深いもの
☐　地位が高い
☐　給料がいい
☐　ストレスがたまる
☐　人気がある
☐　面白い
☐　悪くない
☐　楽しそう
☐　名声が得られる
☐　大変そう
☐　くだらない
☐　職探しが楽そう

(10) 生物に関する知識はあなたの生活をより楽しいものにすると思いますか？

☐　はい　　☐　いいえ　　☐　わからない

ご協力ありがとうございました！

The Use of Chi-Square

(1) ***Goodness of Fit Test***

This chi-square test is to know how much differences between two groups for example , between experimental group and control group. Expected frequency could be calibrated comparing percentage of observed frequency and find differences. This way has not been used in this survey.

(2) ***Contingency Test***

There is different way to have the same result of Goodness of Fit Test. Contingency Test is to know how much difference between expectation of one example and total numbers. Expectation number is calculated by division of total number. For example,

	Positive	*Neutral*	*Negative*
Male (experimental)	55	95	23
Female (experimental)	34	100	43

(Actual data above)

	Positive	*Neutral*	*Negative*	**N**
Male (experimental)	55 **(44)**	95 **(96)**	23 **(33)**	**173**
Female (experimental)	34 **(45)**	100 **(97)**	43 **(33)**	**177**
Totals	**89**	**195**	**66**	**350**

(Expected frequencies above in red)

The expected frequencies are shown in red in brackets **( )**, and are calculated as follows:

e.g. $44 = (173/350) \times 89$

$\chi 2 = 2.75 + 0.01 + 3.03 + 2.69 + 0.09 + 3.03$

$= \mathbf{11.60}$

At two degrees of freedom, this is significant at 1%. ($p < 0.01$) (χ**2** critical at 1% level = 9.21)

Chi-square value must be calculated by the degree of freedom (df) and it is had calculation which is shown below.

df = (number of raw in the contingency table -1) × (number of columns in the contingency table-1)

Limitations on the Use of $\chi 2$

It is known that when values within a category are small, there is a chance that the calculation of $\chi 2$ may occasionally produce inflated results which may lead to wrong interpretations. It is safe to impose a 10 or 5% limit on all categories. When the category falls below either of these, then categories are grouped and the df falls accordingly.

Comparisons of Chi-Square Analyses

There are two ways to approach the analysis of many questions. In the first, a 6x4 contingency test is used. This has the advantage of generating one statistic. The other is to make a series of comparison between year groups. This could generate 6 chi-square values, again using chi-square as a contingency test. Because year 6 is quite different from the grades, only four comparisons were made. The advantage is that this approach shows the stages where changes are occurring in pupil response patterns. This latter approach was adopted in that it offers more information. To illustrate the differences, the eight parts of question 1 are analysed below using both approaches.

Question 1

This question explores aspects of how they see their classes where they have studied biology.

1(a)	I do not enjoy these lessons						χ^2	df	p
Grade 3	7	6	18	28	21	20	53.6	12	< 0.001
Grade 4	8	12	16	33	20	11			
Grade 5	15	14	20	22	19	11			
Grade 6	14	4	14	32	13	23			

1(a)	I do not enjoy these lessons						Comparison	χ^2	df	p
Grade 3	7	6	18	28	21	20	*Grade 3 and 4*	18.6	5	< 0.001
Grade 4	8	12	16	33	20	11	*Grade 4 and 5*	19.5	5	< 0.01
Grade 5	15	14	20	22	19	11	*Grade 5 and 6*	17.8	4	< 0.01
Grade 6	14	4	14	32	13	23	*Grade 3 and 5*	33.4	5	< 0.001

The 6x4 approach gives a significant value which is consistent with the 6x2 multiple approach. However, from grade 3 to grade 5, enjoyment *drops*, with some *increase* in enjoyment in grade 6. However, in grade 6, there is some polarisation of views, with some being very positive and others being very negative.

1(b)	The lessons are interesting						χ^2	df	p
Grade 3	15	18	30	25	10	3	30.1	12	< 0.01
Grade 4	11	20	30	21	9	9			
Grade 5	15	21	28	13	12	12			
Grade 6	16	14	30	19	7	13			

1(b)	The lessons are interesting						Comparison	χ^2	df	p
Grade 3	15	18	30	25	10	3	*Grade 3 and 4*	6.0	4	ns
Grade 4	11	20	30	21	9	9	*Grade 4 and 5*	13.2	5	< 0.05
Grade 5	15	21	28	13	12	12	*Grade 5 and 6*	5.7	5	ns
Grade 6	16	14	30	19	7	13	*Grade 3 and 5*	24.5	4	< 0.001

The 6x4 approach gives a significant value but the 6x2 multiple approach shows the stages where the changes are taking place. The majority of students in all grades are interested in biology but gradually the number of students who are not interested tends to increase although the increase stops after grade 5. Grade 6 students think it is important to prepare for the entrance examination for university.

1(c)	I find biology is difficult						χ2	df	p
Grade 3	12	17	28	26	9	7	42.9	12	< 0.001
Grade 4	18	18	27	25	9	4			
Grade 5	26	23	24	17	7	4			
Grade 6	25	12	27	25	1	9			

1(c)	I find biology is difficult						Comparison	χ2	df	p
Grade 3	12	17	28	26	9	7	***Grade 3 and 4***	5.7	4	ns
Grade 4	18	18	27	25	9	4	***Grade 4 and 5***	17.2	4	< 0.01
Grade 5	26	23	24	17	7	4	***Grade 5 and 6***	7.9	4	ns
Grade 6	25	12	27	25	1	9	***Grade 3 and 5***	33.5	4	< 0.001

The 6x4 approach gives a significant value but the 6x2 multiple approach is needed to show where the changes are occurring.

1(d)	I hate these lessons						χ2	df	p
Grade 3	6	6	19	37	17	15	38.9	15	< 0.001
Grade 4	9	9	20	33	19	10			
Grade 5	15	11	22	25	15	12			
Grade 6	13	7	23	29	18	10			

1(d)	I hate these lessons						Comparison	χ2	df	p
Grade 3	6	6	19	37	17	15	***Grade 3 and 4***	10.9	5	ns
Grade 4	9	9	20	33	19	10	***Grade 4 and 5***	14.3	5	< 0.05
Grade 5	15	11	22	25	15	12	***Grade 5 and 6***	2.4	4	ns
Grade 6	13	7	23	29	18	10	***Grade 3 and 5***	31.4	5	< 0.001

The 6x4 approach gives a significant value but the 6x2 multiple approach is needed to show that it is not a linear change in attitude with little change from grade 3 to 4.

1(e)	I learn nothing new						χ2	df	p
Grade 3	3	4	13	37	23	21	41.8	12	< 0.001
Grade 4	6	5	10	34	25	22			
Grade 5	9	7	15	23	21	25			
Grade 6	12	4	9	32	21	21			

1(e)	I learn nothing new						Comparison	χ2	df	p
Grade 3	3	4	13	37	23	21	***Grade 3 and 4***	5.2	4	ns
Grade 4	6	5	10	34	25	22	***Grade 4 and 5***	24.0	4	< 0.001
Grade 5	9	7	15	23	21	25	***Grade 5 and 6***	5.5	4	ns
Grade 6	12	4	9	32	21	21	***Grade 3 and 5***	28.9	4	< 0.001

The 6x4 approach gives a significant value but the 6x2 multiple approach shows that the key change lies between grades 4 and 5.

1(f)	I am not obtaining new skills						χ2	df	p
Grade 3	5	6	18	37	19	14	15.4	12	n.s.
Grade 4	6	7	18	36	18	15			
Grade 5	10	8	18	29	19	16			
Grade 6	9	5	17	29	19	20			

1(f)	I am not obtaining new skills						Comparison	χ2	df	p
Grade 3	5	6	18	37	19	14	*Grade 3 and 4*	0.5	5	ns
Grade 4	6	7	18	36	18	15	*Grade 4 and 5*	10.0	5	ns
Grade 5	10	8	18	29	19	16	*Grade 5 and 6*	2.1	5	ns
Grade 6	9	5	17	29	19	20	*Grade 3 and 5*	10.1	5	ns

Both approaches are equally applicable.

1(g)	Science (biology) is important subject						χ2	df	p
Grade 3	13	13	32	24	13	5	18.2	12	n.s.
Grade 4	12	18	32	21	11	6			
Grade 5	12	15	28	21	10	14			
Grade 6	19	18	29	16	10	7			

1(g)	Science (biology) is important subject						Comparison	χ2	df	p
Grade 3	13	13	32	24	13	5	*Grade 3 and 4*	4.0	4	ns
Grade 4	12	18	32	21	11	6	*Grade 4 and 5*	16.8	5	< 0.01
Grade 5	12	15	28	21	10	14	*Grade 5 and 6*	7.3	5	ns
Grade 6	19	18	29	16	10	7	*Grade 3 and 5*	6.0	4	ns

The 6x4 approach gives a non-significant value but misses the fact that there is a change between grades 4 and 5.

1(h)	The teacher makes me less interested						χ2	df	p
Grade 3	5	6	18	38	17	17	24.1	12	< 0.05
Grade 4	12	7	19	39	13	11			
Grade 5	9	6	22	36	17	10			
Grade 6	11	2	20	39	10	17			

1(h)	The teacher makes me less interested						Comparison	χ2	df	p
Grade 3	5	6	18	38	17	17	*Grade 3 and 4*	16.6	5	< 0.01
Grade 4	12	7	19	39	13	11	*Grade 4 and 5*	6.9	5	ns
Grade 5	9	6	22	36	17	10	*Grade 5 and 6*	6.1	4	ns
Grade 6	11	2	20	39	10	17	*Grade 3 and 5*	10.2	5	ns

Table 5.10 Data Question 1(h)

The 6x4 approach gives a value of low significance but misses the fact that the actual change lies between grades 3 and 4.