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A Study of Science Student Teachers Perceptions of Learning in the Education Colleges in the Sultanate of Oman

By

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In The Name of Allah, The Most Merciful, The Most Passionate

To

My Parents

&

My Beloved Wife and Children

Abstract

The initial aim of this study was to explore the changes in the students' perceptions of learning over their study years in the education colleges in the Sultanate of Oman.

A number of years ago Perry developed a scheme to describe students' perceptions of learning. Johnstone adapted this scheme. In both the original scheme and the adaptation, the development of students' perceptions of learning was considered in four areas: the lecturer's role, the student's role, the nature of scientific knowledge, and assessment. The Johnstone's adaptation was used in this study. The first stage was to carry out a survey with a sample of 889 students and 1165 pupils from education colleges (age 18-22) and secondary schools (age 15-18). The schools data provided a background against which the student data could be considered. A questionnaire was devised and distributed to three study years in secondary schools and four study years in the education colleges.

The results show that although there is a growth in students' perceptions of learning over their study years, this growth varied from area to area. In the areas of the lecturer's role and student's role the growth was generally good. In the area of the nature of scientific knowledge the growth was very poor while in the assessment area the growth was good in some questions and poor in others.

The results also revealed that students' perceptions of learning correlated positively with their academic performance. It was also evident that females in general had better perceptions of learning than males. In secondary schools, it appeared that science stream students had better perceptions of learning science than arts stream students but this may merely reflect the contextual nature of Perry development.

Based on the findings from the base-line measurements an experiment was designed to tackle the problems revealed. Interactive teaching materials were devised based on problem solving. Then these teaching materials were taught for three weeks to an experimental group of 163 of second year science students' teachers in one education college. These teaching materials aimed mainly to enhance students' perceptions of the nature of scientific knowledge and partially to enhance students' perceptions of assessment. In these teaching units students were encouraged to think about the nature of scientific knowledge and assessment while they are studying science. Pre- and post-questionnaire results were compared between an experimental group and a control group of 155 students. The results showed that the students' perceptions about the lecturer's role improved after applying the teaching materials. In the area of the student's role, there was no change in students' perceptions. A considerable improvement was observed in students' perceptions of the nature of scientific knowledge while, in students' perceptions of assessment, there was slight improvement.

The interview carried out with the experimental group's students after the experiment showed that there was a great satisfaction from these teaching units and the vast majority of students liked the approach used in these units and would like to apply the same approach into school science. In addition, student comments at interviews tended to corroborate the evidence from the questionnaires.

Previous work had shown that the overall structure of the curriculum influenced perceptions of learning with students. This study has shown that students' perceptions of learning can be developed by means of curriculum intervention.

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INTRODUCTION

Many aims can be offered for the higher education process (Allen, 1988). Among these, it can be argued that it is important to develop learners who have acquired the skills of learning and can work on their own and who have gained an appreciation about how to view knowledge in a constructive, critical way. Bowden and Marton (2000) argue that studying at university should prepare students for handling new situations in the future. This is true for all education institutions at all levels: schools, colleges and universities. However, it is particularly important for student teachers in that they will have a powerful influence in the perceptions of learning of the next generations.

Many have argued about the importance of making the students the central focus of the education process in these institutions (Cobb & Bowles, 1999; Richardson, 1999). To achieve this, students at these institutions should be aware of their role and have positive views about knowledge and assessment. They need to view their role as active learners who can find the knowledge they need by themselves, the lecturer's role being to help them to be successful (Kwakman, 2003; Lunenberg & Korthagen, 2003). Brown and Atkins (1988), stress that students should be made aware of their responsibilities in learning. Furthermore, it is important to organise the learning process in such a way that learners can take responsibility for their own learning (Claxton, 1996; Zimmerman, 1990). In assessment, they should view it as a process of measuring their thinking along with their knowledge. To achieve this will not be easy and will require creative hard work of a high order to develop quality assessment.

Students should be given the chance to develop and demonstrate their own ideas. Knowledge should be viewed in such a way that it is not just seen as right or wrong. Students should be able to view knowledge critically, to be able to weigh evidence, to argue in a sustained and logical way, and to appreciate that understanding is constructed. Furthermore, they need to be active learners and to have the skills to work on their own and to contribute positively to their learning. Donald (1999) pointed out the importance of universities to equip students with general and specialized knowledge along with the skills to obtain and make use of the knowledge on a continuous, lifelong basis.

However, if this is true for all students in higher education, it is more important for trainee teachers. Fullan and Hargreaves (1992) argue that teacher development is necessary for educational change. All teacher training programmes aim to develop trainee teachers' skills to teach students to be independent and take some of their learning responsibilities. One of the teachers' duties is to help their students to acquire the skills to work on their own and to be active learners (Jager *et al*, 2002). To do this, the teachers should have these skills and this awareness before they start their teaching. This highlights the importance of helping trainee teachers to develop these skills and this awareness. However, it is often assumed that trainee teachers or other university students will gain these skills by studying for a certain time in universities. Such an assumption may not be well-founded.

The development of students' perceptions of learning is vital. For this, all higher education institutions in general and colleges of education particularly need to make sure that their students are encouraged to develop intellectually and that this should be monitored. Furthermore, the curriculum and teaching methods adopted in these institutions need to consider the importance of developing the students' perceptions of learning. Carven and Penick (2001) argue that the science teacher's view about teaching and learning of science should be challenged. They stress that, without engaging students in the learning process, students will not develop the ability to become self-regulating learners or inquirers. For this, science teacher educators should help their students to view their role as a leader. They also stress that the teachers' view of the world, teaching and learning and their beliefs about knowledge and intelligence have direct influence on their way of teaching.

Perry (1999), through his scheme of intellectual development in the college years, has offered a useful language to measure and understand students' perceptions of learning. This will be discussed in depth in chapter two. Perry gave descriptions of the different stages students go through during their study years in universities. In his scheme, Perry describes the changes in students' perceptions of learning in four main areas: student's role, lecturer's role, nature of knowledge and assessment. He described the changes in students' perceptions using nine positions. He found that most students were in position 5 or 6 when they leave university (see chapter 2).

1.1 EXPANSION OF EDUCATION IN OMAN

Before 1970, there were just three primary schools with just 909 students and 30 teachers in Oman (Oman is a country in the Arabian peninsula with a population of around 2.4m). At that time formal education was a privilege, limited to a small number of citizen in certain geographic areas. In 1970 when His Majesty Sultan Qaboos came to power, education was given a priority as one of the main factors to enhance the development of the country. Rapid quantitative and qualitative changes were carried through in the education field. There have been dramatic increases in numbers of schools, students, and teachers in order to make education available for every citizen.

With all these increases, there was a high demand for new teachers. At the beginning, the majority of teachers were from other Arab countries such as Egypt, Jordan and Sudan. The government also started its own teachers' training programmes to prepare trained Omani teachers. The teachers training programmes went through several series of improvements. These will be outlined in chapter four. In 1996, education colleges were upgraded to be university colleges which offer a bachelor degree after four years of study.

All these rapid changes in education in general and particularly in teacher training present a real challenge to the education system. It is essential among these rapid changes to ensure that students develop the skills needed to be active learners and take responsibility for their own learning and be aware of the importance of these skills in order to be active citizens. To achieve these aims in schools, education colleges should ensure that teacher trainees have these skills and be aware of them. This study aims to explore the development of science education students' perceptions of learning in the education colleges in the Sultanate of Oman.

1.2 AIM OF THE STUDY

This study aims to explore the changes in the students perceptions of learning over their study years in the education colleges in the Sultanate of Oman. The perceptions of learning will be studied in four main areas:

- Student's role
- Lecturer's role
- Assessment
- Nature of scientific knowledge

These areas are defined more fully in section 2.7.

This part of the study will be carried out with a view to the introduction of curriculum intervention in the light of the patterns of the results. The aim will be to see if changes in students' perceptions of learning can be brought about by curriculum intervention. In this study, curriculum intervention was conceived as the use of short learning experiences using specifically designed materials where students would have to interact with situations relevant to the outcomes being sought.

To achieve these aims, an adaptation of the Perry scheme will be used. This adaptation gives a very accessible approach to measure students' perceptions of learning, based on Perry's original ideas. The two main questions to be answered are:

(1) What is the present status of student teachers' perceptions of learning in Oman?
(2) Can curriculum intervention bring about changes in these perceptions?

1.3 THE IMPORTANCE OF THE STUDY

This study has several important points. The first point is to assess the ability of the teachers' training programme, introduced in 1996, in developing students' perceptions of learning. Changing students' perceptions has significant importance for all university students. It is important for students' development. By developing students' perceptions of learning, students become more aware of their own role as active learners and realise that they should encourage their future pupils also to be active learners and to make that central to their education process. This study will try to find effective approaches to enhance students' perceptions of learning through a curriculum intervention.

The second important point relates to research on the Perry scheme. Most work in the Perry scheme of intellectual development has been focused on how to measure that intellectual development or has just suggested some approaches to enhance the intellectual development without providing evidence (Moey, 1994; Selepeng, 2000). One major significant contribution was made by Mackenzie (1999) when she compared a problem-based learning programme and traditional programme with regard to medical students' intellectual development. Her study showed that the problem-based learning programme has a better effect on students' perceptions of learning in terms of Perry scheme. Mackenzie was assessing a whole programme change but it is generally not easy to change the whole of an existing programme. This study will try to find an approach to change students' perceptions by making interventions in the curriculum and teaching methods in an existing programme.

1.4 THE LAYOUT OF THE STUDY

The next chapter will be about the Perry Scheme where the development of the scheme and its core ideas will be discussed. Chapter three will be about different aspects of problem solving, since problem solving is one of the key methods used to develop the curriculum materials used in this study. In chapter four, the education system in Oman will be discussed to give the context for the research carried out.

The remainder of the thesis is in two main parts. The first part aims to find how students' perceptions of learning develop throughout their study years in the secondary schools and education colleges. This will be discussed in chapters five and six. The second part uses teaching materials that have been designed to enhance students' perceptions of learning. These will be presented in chapters seven and eight. This will attempt to show how students' perceptions of learning can be enhanced by means of introducing curriculum materials without having to resort to wholesale re-structuring of the programme. Finally, conclusions will be drawn in chapter nine.

CHAPTER TWO

CHAPTER TWO
PERRY SCHEME FOR INTELLECTUAL DEVELOPMENT IN THE COLLEGE YEARS

2.1 INTRODUCTION

Many educationalists have tried to find ways to view individual human development, especially in the last 50 years. Among these, are Piaget (Slavin, 2000), Erikson (Slavin, 2000), Bruner (Fontana, 1995) and Vygotsky (Slavin, 2000). From this work, it has been concluded that children and adults should be viewed as evolving and growing persons. Furthermore, the view of the student as a passive learner has been replaced by that of an active learner with various stages of intellectual, emotional, and ethical maturity.

One of the first educationalists who was trying to study this development with university students was Perry (Finster, 1989). William G. Perry, Jr., graduated with a B.A. degree in English and Greek from Harvard University in 1935. After he obtained his Master degree in English from the University, he became a Harvard faculty member in 1947. He developed a scheme for intellectual and ethical development. During the 60s and 70s, a longitudinal study was conducted by Perry to investigate this development. When Perry and his colleagues started to study students' intellectual development they were surprised by the variety of ways that students viewed learning. They related this to students' different experiences and the variety of ways in which students went on to assimilate that experience. Lengthy interviews with students from Harvard and Radcliffe Universities were used to develop his scheme of intellectual and ethical development for college students (Perry, 1970).

The Perry scheme has given a language for students and teachers to understand what they all mean, think and believe about learning (Selepeng, 2000). Furthermore, this scheme is a very useful tool for instructors to explore students' minds to assess their needs along with how they view their life at college (Selepeng, 2000).

Perry was very sensitive to students' views and he spent a long time interviewing Harvard students in order to generate his intellectual and ethical developmental scheme. Knefelkamp (Perry, 1999) goes further when he suggests that Perry helps us to understand the nature of students and the nature of development. Perry (1999) himself expressed the view that:

> *"A fundamental belief in students is more important than anything else. This fundamental belief is not a sentimental matter: it is a very demanding matter of realistically conceiving the student where he or she is, and at the same time, never losing sight of where he or she can be"*

As Perry (1999) claimed, this study, despite all its limitations, gives an approach to assess, in a developmental way, abstract structural aspects of knowing and valuing in intelligent late-adolescents.

This chapter will cover different aspects of the Perry scheme. It will outline the original scheme and discuss the adaptations of it. Strategies, which have been suggested to help students to grow intellectually, will be discussed. Finally, the students' perceptions of learning as Perry described them will be discussed in light of other contributions from the literature. This chapter will focus more on intellectual development rather than ethical development.

There is no doubt among educators that learners are the core part of the entire education process. Perry argues that we need to listen to learners in order not to lose sight of where students are or can be in their developmental process through college. The instructors need to answer students as they listen to them as well. In order to do that effectively, instructors need to believe in and respect the students (Selepeng, 2000). Furthermore, Perry was against the idea of being quick either to praise or to be negative against students when assessing them (Selepeng, 2000).

2.2 HOW PERRY DEVELOPED HIS SCHEME

Perry started his research with a sample of volunteers from first year students at the end of their freshman year. They were interviewed and the results showed that students held a variety of perceptions about learning. Perry considered that these reflected student individual differences. Later, in the following years, the same students were interviewed again and the researchers were surprised to find that students' perceptions were developing logically as they progressed. Each step along that progression represented a challenge to the students' world view and how they had responded to it. These challenges might change students' views of learning. A map of development was formed from these changes and the nature of each change. Later, a panel of raters reviewed this map in order to match the interview findings with the Perry team map. The results from this panel gave Perry and his team more confidence that the developmental trends they observed were valid. Arising from these observations, a developmental scheme containing nine positions was developed.

Perry and his colleagues used open-ended interviews to design their initial scheme of intellectual development. Usually they used the *Checklist of Educational Views* (CLEV) as a base to select their sample. They devised this measure in order to identify students along the dimension they desired.

In order to check the validity of Perry findings four judges were invited. Four complete, unedited transcripts of four-year sequences of the interviews with each student were given to them. The judges were asked to rate each of these interviews for each student independently of other judges. After they finished the rating, Perry and his team had a meeting with the judges to discuss their experience. Perry and his team were trying to see if the judges would agree in matching interviews with positions on the chart at a level of agreement not exceeding that attributable to chance (Perry, 1999). The results showed that the interviews were reliable.

2.3 PERRY'S POSITIONS

One of the key contributions Perry makes is the introduction of the concept of *"positions"*. He suggested that students could be in different positions at the same time with the respect to different subjects and experiences. He also argued that the developmental process is continuous in all directions. He made this clear when he said (Perry, 1999):

> '*Perhaps development is all transition and stages are only resting points along the way*'

Through his interviews with students, Perry recognised that there was a pattern in the kind of responses he obtained. He also recognised that, as they progressed through their studies, changes in their view of the world around them were happening. Perry had a strong belief that these positions were not rigid stages, but 'temporary resting' positions (Selepeng, 2000). He argued (Selepeng, 2000) that at any stage during their educational process, students should be viewed as being in developmental positions on a developmental continuum.

According to Perry, in order to help students to develop intellectually, they should be encouraged, rather than forced, to move toward high Perry positions (see table 2.1 and figure 2.2. He believed that understanding students development started with their voice, their experiences and their meanings.

2.4 THE ORIGINAL SCHEME

The Perry scheme originally had nine positions and according to Finster (1989), these nine positions can be categorised into four main positions as shown in table 2.1. In the following few pages, the original scheme will briefly be outlined followed by a detailed discussion of Johnstone's (1998) adaptation of the scheme.

Table 2.1: Illustration of the categorisations of the Perry Positions

CATEGORY	**DUALISM**	**MULTIPLICITY**	**RELATIVISM**	**COMMITMENT IN RELATIVISM**
POSITIONS	1 & 2			
		3 & 4a		
			4b & 5	6, 7, 8 &9

Perry developed nine positions for students during their study in their college years. Position four was divided into two sub positions. These positions were arranged into a developmental continuum. He called these positions 'forms' or 'structures' of intellectual and ethical development. He noticed that the students' views became more complex and sophisticated as they progressed through their study years at college (with position 1 as the most basic and position 9 as the most advanced) (Selepeng, 2000). Figure 2.1 shows a brief outline of the Perry scheme of ethical and intellectual development.

9. Resolve
8. Multiple Commitments
7. Initial Commitment
6. Anticipation of Commitment
5. Contextual Relativism
4b. Relativism Subordinate
4a. Multiplicity Correlate
3. Multiplicity Subordinate
2. Dualism-multiplicity Pre-legitimate
1.Basic dualism

Time scale: progress from year to year

Figure 2.1: A brief outline of the nine positions in Perry's scheme of intellectual and development illustrating how the levels overlap

Positions 1 to 4b elaborated to dualism according to Perry. In these early positions, students view knowledge as right or wrong, good or bad, black or white. From the fifth position students start to recognise the contextual nature of knowledge. The last four positions involve the various processes undergone by students as they strive to make commitments in association with different aspects of their lives (Selepeng, 2000).

Perry and his colleagues observed that college students are usually somewhere between positions 2 and 5 in most aspects of their learning. They also noticed that students are usually beyond basic dualism by the time they reach college (Selepeng, 2000). The positions are now discussed in more depth.

2.4.1 Main Line of Development

Position 1: "The students see the world in polar terms of 'we-right-good' vs. 'other-wrong-bad'. Right answers for everything exist in the absolute, known to authority (Perry uses the word authority to describe sources of information such as teachers, textbooks, lecturers and other students) whose role is to mediate (teach) them.

Knowledge and goodness are perceived as quantitative accretions of discrete rightnesses to be collected by hard work and obedience (paradigm: a spelling test)".

Position 2: "The student perceives diversity of opinion, and uncertainty, and accounts for them as unwarranted confusion in poorly qualified Authorities or as mere exercises set by authority "so we can learn to find the answer for ourselves" (Perry, 1999).

Position 3: The student supposes that precise the right answer is not completely adequate to gain full marks in the assessment. Exactly what is required is not clear and the student would like some precise guideline about what is expected.

Position 4: "This position can be divided into two sub-positions: (a) The student perceives legitimate uncertainty (and therefore diversity of opinion) to be extensive and raises it to the status of an unstructured epistemological realm of its own in which any authority's realm where right-wrong still prevails, or (b) the student discovers qualitative contextual relativistic reasoning as a special case of what they want within the authority's realm".

Position 5: "The student perceives all knowledge and values (including authority's) as contextual and relativistic and subordinates dualistic right-wrong functions to the status of a special case, in context".

Position 6: "The student apprehends the necessity of orienting himself in a relativistic world through some form of personal commitment (as distinct from unquestioned or unconsidered commitment to simple belief in certainty)".

Position 7: "The student makes an initial commitment in some area".

Position 8: "The student experiences the implications of commitment, and explores the subjective and stylistic issues of responsibility".

Position 9: "The student experiences the affirmation of identity among multiple responsibilities and realizes commitment as an ongoing unfolding activity through which he expresses his life style".

Perry has developed a very useful scheme which seems to reflects students' perceptions of learning in higher education. However, the nine positions of his scheme are too complicated in practice. For this reason, many researchers have tried to simplify it, like Finster (1989) and Johnstone (1998).

2.5 FINSTER CATEGORIZATION OF PERRY'S POSITIONS

Perry's nine positions were then categorized (Finster, 1989) into four main categories: Duality (positions 1, 2), Multiplicity (positions 3 and 4a), Relativism (4b and 5) and finally Commitment to Relativism (positions 6,7,8 and 9) (see table 2.1).

Dualism

Dualism consists of the simplistic right/wrong or black/ white view. Correct answers always exist, and learning them is paramount – the more of this knowledge which is ingested, the better the student (Gray, 1997). Knowledge is viewed as an absolute and any uncertainty is temporary (Finster, 1989). They also believe that each question has an answer and the authority's job is to give the answers.

Multiplism

Mulitiplism represents positions three and four. In this main position, diversity and uncertainty are recognised but the student is not sure which idea he should follow from the conflicting ideas he has seen. He needs the authority to supply the guide. Furthermore, diversity and uncertainty are recognized as legitimate to the point where anyone has a right to his or her own opinion and all opinions are equal, even those of an authority (Finster, 1989).

Relativism

At this category, the student recognizes that knowledge is contextual and relative (Finster, 1989). Even if the right-wrong may apply, it should be applied only within certain contexts and never to make that decision outside the context (Finster, 1989). Students start to realize that personal commitment is necessary to establish an identity and make sense of all opinions. Unfortunately, in this position students cannot make that commitment. Even if students start to realise that knowledge depends on context, they have not attempted to structure their knowledge.

Commitment in Relativism

Commitment involves the individual making a choice or decision in the full awareness of relativism. In this category, the student orders his knowledge, recognising that decisions can be made only on a basis of uncertainty. He is prepared to take risks to do so.

From Perry's study, no freshman student was found to be in position 1 at the end of first year, but some of them described themselves to be at that position when they arrived at the college (Perry, 1999). It was found that, at the end of year one, students tended to be at positions 3,4 or 5 (Ramsden, 1988) and most of the final years students were found to function in positions 6,7 and 8. However, Perry thinks from his work that position 9 is beyond the level he can expect the experience of a college senior to achieve.

2.6 CHANGES TO THE MODEL

The Perry Scheme, as originally developed by Perry and his associates, is clearly very complex but it has to be accepted that it reflected what Perry found from his interviews. Attempts have been made to simplify it, like the four categories of Finster (1989). Each of these four categories has grouped several of the original positions which seem to possess similarities. This arose from the cumulative data which arises from applying the scheme again and again by different researchers to different students groups (Moey, 1994; Selepeng, 2000; Mackenzie & others, 2003). Another attempt was made by Johnstone (1998) to put the scheme in more easily applicable way without altering the core ideas of the Perry scheme. In this attempt, the Perry scheme was reorganized into three main positions: A, B and C.

Another criticism of Perry's scheme is with regard to Perry's sample. Not only is the original Perry scheme complex, the sample size and type raise many questions about the validity of generalization. The Perry study was originally conducted with just 84 students and this number seems to be too small for safe generalization. In addition, these students were in one college, which raises questions about the students in other universities, colleges and specializations. Socio-economic class, age, and background were always a doubt about the original sample as well.

Keeping in mind that Perry's study only included two complete four year reports for women and the rest were men, a question of gender differences may also be raised. However, judges found out that there are no differences in the structure of the scheme between men and women, the only difference being in the way that each of them will express their perceptions. Perry made it clear when he said:

> *"They concluded, however, that for the purposes of the study these differences were evident in the content and manner of the students' rather than in those structurings of experience relevant to the developmental scheme" (Perry, 1999).*

He also mentioned that:

> *"the judges' statement that they experienced no significant difference in locating men's and women's reports on the chart of development" (Perry, 1999).*

The ways the samples were chosen might raised other doubts as well. The first sample was chosen using the *"Checklist of Educational Views"* and the second sample was chosen randomly but the main issue here is that both samples were chosen only from volunteers. A question of the other students' perceptions (non-volunteers) is valid here.

The longitudinal interview method used by Perry to assess students' intellectual development was judged to be time consuming and not applicable to large numbers of students. Furthermore, one of the weaknesses of interview is that the interviewee might hide some information during the face to face situation (Gay, 1981;Cohen & Manion, 1997). The idea of designing a new assessment method, which will be valid, reliable and applicable to large number of students, was developed by several researchers. A method of assessing students' intellectual development is to ask students to respond to a series of essays concerning their perspectives on good learning environments, disquieting decisions career development concerns (Perry, 1999). This method was called the Measure of Intellectual Development (MID). Beside making sense for students, this method can be used for large numbers of students within a class period.

The Learning Environments Preference (LEP) is another instrument developed to measure the Perry scheme. It was designed by Moore (Perry, 1999) and it was the most widely used 'paper and pencil' measure of the Perry scheme. In LEP, students are asked to select from a list the items that reflect their thinking about some learning issues such as instructors roles, students and peers roles, assessment and the nature of science. Results from LEP will show student's position and transition. However, most researchers use a combination of MID and LEP and Perry interviews.

Perry claimed that most research showed that males and females usually have the same Perry positions patterns even if they used different cognitive and affective cues within the positions (Perry, 1999).

One of the criticisms made about the Perry scheme is about the cultural perspectives and values, which will affect students' views of learning. Since the original scheme was designed based on the western culture and values in the 50s and 60s, a big question may rise about the applicability of the scheme today with its different cultural settings.

However, the development and use of the written assessment procedures, which facilitated the conducting the scheme with tens of thousands of students at many colleges and institutes, helped to overcome many of these doubts. The results from these showed that the Perry scheme was applicable to a wide range of students. An example of these assessment methods is Harvey's (1994) questionnaire, which was built using the Likert (1932) format. Mackenzie (1999) used a questionnaire to measure students' intellectual development and finally, Selepeng (2000) developed another questionnaire based on Osgood's method (Osgood, 1952; Osgood, 1967). These questionnaires will be discussed in greater depth later.

2.7 JOHNSTONE'S ADAPTATION OF PERRY'S SCHEME

In the late 1980s, attention was given to the Perry scheme by Johnstone. As a result of this attention, an adaptation of the scheme was made. This adaptation of the scheme is shown in table 2.2 and he reorganized the scheme into three main positions. This made the scheme more applicable without changing the core issues of the Perry scheme. This adaptation is used in this research.

While Finster used 4 categories, Johnstone developed a scheme with three categories covering four area of learning (see tables 2.2 and 2.3). Johnstone has developed categories as A, B and C.

Table 2.2: Illustration of the Johnstone's categorisations of the Perry Positions

CATEGORY/ POSITION	DUALISM	MULTIPLICITY	RELATIVISM	COMMITMENT IN RELATIVISM
A	1 & 2			
B		3 & 4a		
C			4b & 5	6, 7, 8 &9

Source: (Selepeng, 2000)

It is clear from table 2.2 that position A represents positions 1 and 2, where dualism is still strong. In position B, the student starts to realise the problems that surround dualism but still has problems dealing with multiplicity. Indeed, it is the most uncomfortable position for students. Position C is the highest position, (including all positions from 4b onward till position 9 in the original Perry scheme). Even if Perry said that most students in the final college year are between positions four and five, that does not mean that it is impossible for some of them to be in higher positions. Since it is very rare to have students between positions 6 to 9, Johnstone put them with positions 4b and 5 in one position, which is his C position.

However, on the following pages, these three positions will be discussed in depth in order to give the reader a clear view of this adaptation for the scheme. Each of these main positions will be discussed separately. Furthermore, for each position, the students' perceptions about the four areas related to learning will be considered critically. These four areas are: the role of lecturers, the role of students, the view of knowledge and the view of exams as Johnstone illustrated on his adaptation. Table 2.3 shows Johnstone's adaptation.

Table 2.3: Simplification of Perry's Scheme Model by Johnstone

	Student A	Student B	Student C
Student Role	Passive accepter	Realises that some responsibility rests with the student. But what? And how?	Sees student as source of knowledge or is confident of finding it. Debater making own decisions.
Teacher Role	Authority giving facts and know-how	Authority where there are controversies, wants guidance as to which answer lecturer favours.	Authority among authorities. Values views of peers. Teacher as facilitator.
View of Knowledge	Factual; black and white. Clear objectives, non-controversial exceptions unwelcome	Admits 'black-and-white' approach not always appropriate. Feels insecure in the uncertainties this creates.	Wants to explore context; seeks interconnections, enjoys creativity scholarly work.
View of Exams	Regurgitation of 'facts'. Exams are objective. Hard work rewarded	Quantity is more important than quality. Wants to demonstrate maximum knowledge	Quality is more important than quantity. Wants room to express own ideas, views.

Source: Johnstone (1998)

Johnstone's adaptation has several advantages: It simplified Perry ideas and covers all four main areas related to learning. Furthermore, the language used is accessible to all.

2.7.1 Position A

This is the lowest position of students' views to their educational life. In this position, the world around students is viewed in a clear-cut manner. All issues are either right or wrong, good or bad, true or false. Perry (Perry,1999; Selepeng, 2000) argued that qualitative meaning has no place in this position. Authority has the only right to give the right answer for all questions and all other opinions and views cannot be considered and cannot be right. Furthermore, the authority has the only power to weigh opinions and select the correct one for students.

(i) Roles of lecturers

Lecturers or instructors are viewed as authority and authority is always right. Because of this they can be distinguished from students. What the lecturer says must be accepted by students without questioning.

Perry found (Perry,1999; Selepeng, 2000) that most students will not be in this position when they reach university level. This may be related to a social world where content is highly questioned. In the world of today, most young persons know their rights and are not subservient to authority. Thus, when they reach university level, only a small percentage of them are still in position A. However, even those who are still in this position will give up as soon as they realize that life in university is not that straight forward.

(ii) Role of Students

Since the lecturers are the only authority, students should obey them without questions. Students also have responsibility to learn everything give by the lecturer, which always reflects the truth. Furthermore, students have no right to play a role in finding the deeper meaning of things given by lecturers. They do not try to expand their knowledge by themselves because they think this is not their task do so (Perry,1999; Selepeng, 2000).

Students do not see that they have any role relating to challenging the accuracy of knowledge. They consider that, if they oppose the view of lecturers, their viewpoint would immediately be dismissed in favour of the lecturer's standpoint (Perry,1999; Selepeng, 2000).

(iii) View of knowledge

Knowledge, which has been given by authority, represents the absolute truth. According to Perry, in teaching, the lecturers are mediating between this absolute truth and the student. "Judgments can then be made between those who know their stuff and can mediate well and those who don't know, mediate badly and are more likely to be 'impostors'" (Perry,1999; Selepeng, 2000).

One of the interesting things that Perry noticed is that these students seem to give their lecturers the liberty to enjoy exploring these other 'wrong interpretations', as long as they are not brought into play where instruction is concerned (Perry,1999; Selepeng, 2000). All that is expected is for the instructors to 'stick to the facts' and do 'less theorising', as some Perry's students put it (Perry,1999; Selepeng, 2000).

It has been noticed that, even if students can differentiate between good and bad authority, that does not mean they can accommodate this in the nature of knowledge itself (Perry, 1999; Selepeng, 2000). In general they always expect one right answer for each question.

(iv) View of exams

Students at this position assume that the assessment procedures are free of ambiguities. This is related to their view that each question has a clear-cut answer. A good student should know all the right answers. Furthermore, they view questions which demand students' opinions and interpretations as too much of an unnecessary challenge. However, students do not like to give their own opinions in assessment for two main reasons (Perry, 1999; Selepeng, 2000). Firstly, they think that there is only one right answer for each question, and the role of the lecturer is to provide this. Secondly, they think that they are not capable of giving their views or interpretations.

According to Perry, those students entering college at this position, with this rigid and closed view of assessment, will have difficulty in surviving the degree course. He thinks that, after these students interact with their colleagues outside the college and get exposed to extra-curricular discussions where they tend to oppose each other's views, they will start to change their view of assessment. This will then be transferred to the classroom. However, toward the end of this position students do realise that multiplicity in opinion does exist but this still does not change the fact that the 'right answer' exists (Perry, 1999; Selepeng, 2000).

2.7.2 Position B

(i) The role of lecturers

Students start to view the lecturer as the person who is responsible for teaching them the correct ways of finding the right answer. Students are beginning to realize that they have responsibilities toward learning but they still want the lecturer to show them how. This is because they do not know what to do.

(ii) The Role of Students

During this position, students start to realize that they have some responsibilities toward their own learning, but they do not know what to do. Furthermore, they start to believe that their role as students is more than a passive accepter of what has been given by the lecturer. However, they do not know what is needed or what should be done by them. They want directions from the lecturer (Perry,1999; Selepeng, 2000).

Students start to recognize that peers might be able to help them in finding the way to find the right answer through discussion. However, even if a student starts to trust his/her peer, the lecturer is still seen as having the final say and he is the source of knowledge (Perry; 1999; Selepeng, 2000).

In general, students are in great confusion and uncertainties during this position.

(iii) View of knowledge

In this position, students start to accept that in some situations the truth or the right answer is out of reach. This may lead them to accept that uncertainties are legitimate. However, that does not mean that they change their belief that there is only one right answer. The only right answer is not available in this situation because the proper ways of finding it is not available yet (Perry, 1999; Selepeng, 2000).

Students also start to accept that the lecturer does not always have all the right answers, but they become puzzled as to how the lecturer can then go on to evaluate the student's answers if he does not know the right answers yet himself (Perry, 1999; Selepeng, 2000).

(iv) View of Assessment

Assessment at the end of the day has a great importance for the student since it reflects the quality of his learning. The students in this position become confused about what is expected from them and they hope to be able to present one argument, which will make the lecturer like their line of thought. They hope this will lead to examination success. They will try their best to make their answer suit the lecturer's way of thinking but this will make them still feel they never know when and why they are going to be either marked down or up. They still believe in rewards for quantity of hard work and not quality of work. For them, the amount of work done by students should be taken into account. They think that Multiplicity will involve an increase in workload. They are expecting to take in everything and they are not expecting to be asked to make their own judgement, which may make them complain about the amount of work needed for exams (Perry, 1999; Selepeng, 2000).

2.7.3 Position C

This position is the highest position in Johnstone's adaptation of the Perry scheme

(i) The role of lecturers

He views the lecturer as an authority but among other authorities such as books, papers, other teachers, his peers and even himself. Lecturers are viewed as a facilitator of learning rather than merely offering knowledge.

(ii) The Role of Students

The student accepts responsibility for his own learning. Furthermore, he feels confident to seek expert help of many kinds. Other students are viewed as other authorities or sources of knowledge. With this view students are not passive learners.

(iii) View of knowledge

The student in this position appreciates that knowledge is contextual and that more than one answer can be legitimate. He also realises that knowledge is constructed in his own mind from a variety of sources not just one source, the lecturer. In this position, the student understands the difference between facts and opinions (Perry,1999; Byrne, 2001).

(iv) View of Assessment

Students see tests and examinations as opportunities to demonstrate their skills in relating between contexts, to seek interconnections, to expand and modify concepts, to weigh up alternative approaches and to aim for scholarly work in which comparison and contrast are considered. He enjoys being creative and playing with ideas. For them, quality is now seen as more important than quantity. Student C does not like short questions, as they do not give him the chance to explain what he knows and understand.

2.8 THE RELATIONSHIP BETWEEN A DEGREE OF CONFIDENCE AND PERRY'S POSITIONS

Wood and Sleet (1993) showed that students A and C have high confidence unlike student B who has a low confidence figure 2.2.

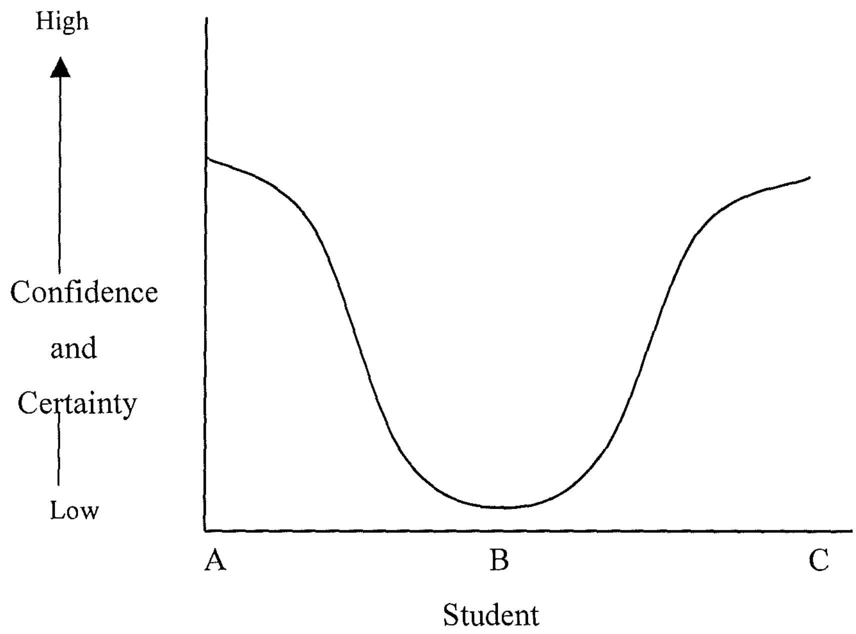


Figure 2.2: The Change in Certainty of Knowledge and Confidence as Students Progress Though Perry scheme

Source: (Wood & Sleet, 1993)

Student A feels more confident because of his reliance on the authority whereas student C relies on himself, leading to confidence. Since student A considers the lecturer as the only source of knowledge, then his full trust is given to what the lecturer says. Student C, using many sources of knowledge, comes up with his own ideas about an issue.

Student B tends to lose his confidence in both authority and himself. For him, knowledge is not black or white, wrong or right any more but he does not know how to deal with this situation. His role is more than a passive accepter but he cannot work out his new role. He realises that the lecturer is not the only source of knowledge but this still leaves him with much doubt about the other sources and he still wants the lecturer to confirm the other sources for him. All this leaves student B with more doubts and uncertainty about his learning and makes him less confident.

Johnstone (1998) summarised this pattern of confidence when he stated that:

> *"In terms of confidence, Student A is confident in the system: the teacher, the lecture, the exam. Student C is confident in himself and in his ability to learn on his own or in a group or by whatever method he finds congenial. Student B, however, sits in a trough of uncertainty and low self-esteem"*

2.9 HOW TO DEVELOP STUDENTS' INTELLECTUAL DEVELOPMENT:

Many attempts were made to come up with some ideas to help students to develop intellectually (according to the Perry scheme). Unfortunately, all these attempts tended to be theoretical. There was little attempt to try to test them or design experiments to support their ideas. A major contribution, however, was made by Mackenzie (1999), who compared problem based learning with the traditional course of teaching medical students at the University of Glasgow. This research showed that the problem based learning course was better than traditional course in term of students' intellectual development. Mackenzie (2003) made a breakthrough with the Perry scheme by developing a practical and easily applicable instrument to measure students' perceptions of learning. She devised a very precise questionnaire, which could be used with large numbers of students and is relatively easy to analyse.

Several other authors suggested strategies to encourage positive Perry growth. However, nothing of these ideas was tested practically. In the following few pages some of these ideas are discussed.

In the context of chemistry, Wood and Sleet (1993) offered same useful guidelines which seem reasonable. They argued that changes are required in context, presentation and expectation rather than in content in order to develop students' positions. They suggested some guidelines that change or keep student's position.

To keep students at level A, make them feel comfortable and secure by doing the following (Wood & Sleet, 1993):

- *"Avoid anything controversial, any exceptions, anything where the teacher says 'it is not known'.*
- *Do not require students to evaluate source of information critically other than information provided by teacher.*
- *Go over many examples of the same thing.*
- *Examine knowledge only.*
- *Make practical work verify theory, give 'blow by blow' instructions with detailed (mindless?) recipes to follow, mark only the finished article of a practical report.*
- *Do not ask awkward questions during practical work.*
- *Be available at all times to answer questions".*

To challenge level A student's perception, and encourage him toward B and on to C:

- *"Teach general problem solving strategies as opposed to the method for specific problems.*
- *Give students some responsibility for finding information from a variety of sources and for designing their own practical work.*
- *Direct students to sources of information which may sometimes disagree*

- *Provide group problems on paper and in the laboratory to foster peer group discussion."*

Sanford claimed (1985) that, in order to enhance developmental growth, students required appropriate challenges to stimulate changes in ways of thinking. By appropriate challenges he was thinking of putting students into learning situations which would encourage a positive development. Based on that, he argued that this is the key factor of the developmental instruction.

Sanford's view is connected with those who have adapted Perry ideas. It has been suggested that to promote students' growth within Perry's scheme, it is helpful to instruct them with some challenge at roughly what is call 'plus one (+1) level. Studies found that more progression along the scheme happened when students are challenged to work slightly above their present levels (Finster, 1991). Furthermore, it was suggested that to help dualistic students to develop to multiplistic thinking, their dualistic perceptions should be challenged by multiplistic perspectives of an issue. This makes them think how the dualistic way of thinking may not work in many situations, which may encourage them to change their way of thinking.

Finster (1991) found that college students are usually at positions 2-5 and those in the first year usually in the 2-3 range. He also found instructors to be between position 6 and 9. Instructors during their discussion of their teaching strategies and their views of education could be categorised according to their discussion to dualist (10%), multiplist (30%), relativist (45%), and committed to relativism (15%). However, in their real teaching in classrooms, it appeared that they functioned at advanced Perry levels. This may lead us to suggest that in some cases they might be a gap between instructors' perceptions about Perry scheme and their real teaching in the classrooms.

An assumption was made by Finster (1991) that the instructors' understanding of Perry issues help them to create a better learning environment. It could be taken further to suggest that most important is their beliefs about Perry rather than their understanding. Instructors' beliefs about Perry's ideas are the main motive for them to encourage their students to develop intellectually. Without these beliefs, their understanding will not help much in changing their ways of teaching. It was stated

(Finster, 1991) that if the students were given the choice they would choose solutions that represent their own position or the +1 position along the scheme. Following this, students' choices of possible perceptions related to learning offer a way to measure students' positions. It might be concluded that in order to enhance students' intellectual development, we need to improve the learning environment and that can be done by making teachers more committed to Perry scheme.

It was suggested by many (Gray, 1997, Finster, 1991), that students' positions in the Perry scheme are contextual. This means that the same student may be at one position in one area but at another position in another area. With regard to science, Finster (1991) stated that it is easy to encourage students to function at a relativism position in a literature course rather than a science course. This might be explained in the light of divergent and convergent thinking. Since the science students tend to be convergent thinkers (Hudson, 1966), that might lead them to deal with science dualistically. As it is known that convergent thinkers tend to be narrower in their thinking and they use concise approaches and language whereas divergent thinkers are more capable of elaboration and giving a variety of responses. It was stated that science students tended to be convergent thinkers whereas arts students to be divergent students. However, Johnstone and Al-Naeme (1995) found that divergent thinkers did better than convergent thinkers when it comes to science. Convergent thinking might be encourage if the approaches used to teach science encourage students to think dualistically. This can be done by putting students into situations where there more than one answer.

When instructors teach using a certain position some students will be challenged but for others it might be not a challenge at all because of individual differences between students (Finster, 1991). However, the problem of dealing with the individual differences is an old issue in education and many ways were suggested to overcome this problem. Since students in the same class might vary in their intellectual development, instructors' activities should vary as well in order to match all students' intellectual development. Furthermore, there is a need for personal freedom for students during teaching in order to give them the chance to choose their preferred way of learning.

It was pointed out that a student tends to work at low positions when introduced to disciplines even though he is at higher position in other more familiar areas (Finster, 1991). However, with regard to general chemistry, Finster made an assumption that students mainly function at the 2-3 positions. To help students to move to higher positions and leave dualism, Perry argued that the key factor is to give them diversity (Finster, 1991) whereas Knefelkamp (Finster, 1991) suggested four main variables to challenge and support them in the classroom: degree of structure, degree of diversity, type of experiential learning and amount of personalism. Table 2.3 shows how he presented his ideas but his model is complex.

Table 2.4 Matrix of challenge/Support Issues for general chemistry classes

Note: The following guidelines represent general activities and strategies for functioning in challenging and supportive ways. Any given class or course may have a complex mixture of these tasks that represents a unique and appropriate balance of challenge and support.	
Support for Dualists	
Structure	Lecture; provide a context for studying chemistry; define new terms clearly; carefully sequence from simple ideas to more complex ideas; have lecture text, and labs coincide in content and time; provide help sessions to go over problem sets; hold practice exams; provide detailed syllabus for course; provide a clear set of expectations and grading scheme; use copious examples of problem solving; overtly relate lab and lecture material; use examples that relate to student's own experiences; assign homework sets that parallel text material; provide clear guidelines for lab reports; objective tests; minimize student participation in class; test towards lower parts of Bloom's taxonomy.
Diversity	Minimize diversity of learning experiences, i.e., avoid multiple (and certainly contradictory!) sources of information, (lecture, texts, extra readings, etc.); avoid team-teaching; minimize " exceptions to the rule" for theories and patterns.
Experiential learning	Use lecture demonstrations and lab experiments to verify and cement lecture ideas and principles as much as possible; relate examples in chemistry to previous experiences in student's lives (such as the fogging of a car window or melting ice with salt); provide labs that work with materials known to the student, (e.g., salt, baking powder, vinegar, battery acid, and other common substances used in everyday life.)
Personalism	As the professor, be available for office hours, hold discussions sections in reasonably small groups, circulate in the lab, be available before and after class, create a comfortable learning environment (by using positive affect, positive reinforcement,) display enthusiasm for learning and chemistry; use personal (but not inappropriate) anecdotes and self-disclosure; comprehensive and detailed feedback on test labs.
Support for Multiplists; Challenges for Dualists	
Structure	Organize the course with some opportunity for flexibility in terms of content and sequencing; provide directions about how to generate problem solving strategies (rather than presenting rote examples); structure group work and analysis of lab results by groups; have students control/design some aspect of the learning experience.
Diversity	Discuss various approaches to models and theories, various interpretations of results; use sources beyond professor and text; let the sources disagree when propitious; examine exceptions to rules.
Experiential learning	Provide concrete experiences that rely less on authorities and more on peers and self, e.g., case studies analysed in groups, projects/labs done in teams.
Personalism	Create an environment (in lab or discussion groups) that encourages more risk-taking and disclosure of independent thinking on the part of the student; use positive feedback techniques to foster participation: more discussion of issues related to chemistry (as opposed to traditional textbook content.)
Support for Relativists; Challenge for Multiplists	
Structure	Provide more independent learning environment; present professor as a source of expertise or guide; design flexibility in course content and topic sequencing and encourage student participation in altering schedule; encourage students to develop their own definition of problems and work out their own solutions, e.g. Select own term paper topics, length and format; let the students select their own labs and modify design; team teaching; provide historical of societal context of course content; test across the whole range of Bloom's taxonomy.
Diversity	Present issues of both qualitative and quantitative diversity, particularly with non-traditional topics; let students argue merits of competing theories or interpretations.
Experiential learning	Encourage/require projects that are defined usually by the students; independent studies in the lab, rely on more vicarious and abstract learning experiences.
Personalism	Optimize class participation by students; present professor as "expert learner" or guide.

Source:Finster (1991)

Finster (1991) suggested some strategies to help students to develop intellectually these are now summarised.

Lecture

In order to enhance students to move from a dualist position, comments and discussions should be interjected within lectures in order to challenge dualist thinking.

Laboratories

There is no doubt that the laboratory plays a vital role in science teaching but it could be a harmful experience in terms of Perry's scheme if it is misconducted. Laboratories, which are highly structured will encourage students to be a dualist thinkers. On the other hand, open ended laboratories and discovery laboratories are more helpful to help students escape the dualist position.

In general, students especially at the start, feel safer to deal with a structured laboratory. However, such a structured laboratory can degenerate into a situation where students can be rather like cooks who are following a recipe book without knowing what they are doing. For dualistic students, the open-ended laboratories are a potential waste of time. The best way to tackle this problem to help students move away from dualism is by helping them get comfortable functioning in a lab rather than to try to structure a developmental environment (Finster, 1991).

Tests

Tests have special importance to students, teachers and all those dealing with education. Some educationists argue that the education process is unfortunately driven by tests and the assessment process. It is argued that the content and style of a test have an important message to students about the nature of science and their intellectual development. In order to help them to move from dualist position, the assessment process should include history of science, process, application and problem solving that challenge students' thinking.

The style of tests has a key influence on students' intellectual development. Multiple choice questions for example, encourage students to think dualistically even if designed to go beyond recall issues because, at the end of the day, students are asked to select one right answer.

Writing in science

The way that students are encouraged to write in science could have a significant effect for or against their intellectual development. The laboratory report is a good example, and by designing laboratory reports to just fill some blanks with fixed answers, students are encouraged to think dualistically since no challenge to their dualist thinking is made (Finster, 1991). However, that does not mean making questions not understandable but trying to make them divergent in order to challenge students' dualistic thinking.

The other way to challenge students is the use of journals by asking students to criticise scientifically what is in those journals and put their ideas in written form. Furthermore, if students are asked to write assignments, they should be encouraged to examine science for more than a body of knowledge and go beyond that to science process and scientific thinking.

Finally, Finster (1991) thinks that chemistry is usually viewed and taught dualistically and first year students in the college are usually dualistic in thinking. Indeed, it might be true for other subjects as well. Science students may be tempted to think that there is just one answer. In other words it is possible that science students at the beginning of their college years are encouraged to think convergently.

2.10 BELIEFS ABOUT KNOWLEDGE AND PERRY'S SCHEME

Many studies showed that the students' beliefs about knowledge have great consequences on academic performance and critical thinking (eg. Bruning *et. al*, 1995). Ryan (1984) concluded from his experimental test of Perry's basic framework that the relativists, along with their different beliefs about knowledge, also have different approaches to learning (a more sophisticated way) when compared to dualists. He found that:

- *Dualists do not do as well as relativists when final grades are considered.*

- *Dualists tend to search for fact-oriented information while studying, whereas relativists tend to search for context-oriented information.*

Dualists generally rely on remembering information which is reported explicitly in the text. Non-dualists try to construct a meaning from the text or to make an overall framework that summarizes the main ideas of the text. Prosser and Trigwell (1999) argue that most students enter university with absolute view of knowledge and they may leave university with the same view.

2.11 RELATIONSHIP BETWEEN ACHIEVEMENT AND INTELLECTUAL DEVELOPMENT

A study by Byrne (2001) showed that the Perry score of intellectual development is significantly correlated with the overall degree mark and the examination mark. This might lead to the suggestion that, by encouraging students to think in higher levels of the Perry scheme, the teacher may contribute positively to their academic performance. However, a very important point, which should be kept in mind is the nature of the examination. If the exams were designed to assess students at high levels of the Perry Scheme, then they will correlate positively with Perry score, but if the exams are designed according at lower levels of the Perry scheme, then they might not correlate so positively with Perry scores. The nature of assessment plays a vital role here.

The work of deep and surface learning approaches (which is in some ways similar to Perry) comes up with similar patterns. On surface-level processing, students direct their attention toward learning the text itself whereas in deep-level processing, students are directed toward the intentional content of the learning material (Richardson, 2001). Marton (Richardson, 2001) found that there was a clear relationship between the students' levels of processing when they are reading academic text and their academic outcome from that text. Finally, the use of deep or surface approaches seems to be contextual (Richardson, 2001) as it is the case for Perry's scheme. Assessment has important effects on deep or surface learning. If assessment designs to measure a deep learning then the students will be encouraged toward deep learning.

2.12 BAXTER MAGOLDA'S EPISTEMOLOGICAL REFLECTION MODEL

Magolda and Porterfield (Richardson, 2001) tried to reconcile Perry's original model to develop a structured instrument called the Measure of Epistemological Reflection. This model (Richardson, 2001) contains different domains: decision making, the role of the learner, the role of the instructor, the role of peers, evaluation of learning and the nature of knowledge. It is clear that this model reflects similar core issues to Perry's schemes. Table 2.4 shows Magolda's Epistemological Reflection Model. However, this model will not be used on this study. It has interesting features and similarities to the Johnstone adaptation of Perry scheme. However, Johnstone's model is very much based on experimental evidence rather than a logical analysis.

Table 2.5: Baxter Magolda's Epistemological Reflection Model

Domains	*Absolute knowing*	*Transitional knowing*	*Independent knowing*	*Contextual knowing*
Role of learning	Obtains knowledge from instructor	Understands knowledge	Thinks for self Shares views with others Creates own perspective	Exchanges and compares perspectives Thinks through problems Integrates and applies knowledge
Role of peers	Share materials Explain what they have learnt to each other	Provide active exchanges	Share views Serve as a source of knowledge	Enhance learning via quality contributions
Role of instructor	Communicates knowledge appropriately Ensures that students understand knowledge	Uses methods aimed at understanding Employs methods that help apply knowledge	Promotes independent thinking Promotes exchange of opinions	Promotes application of knowledge in context Promotes evaluative discussion of perspectives Students and teachers critique each other
Evaluation	Provides vehicle to show instructor what was learned	Measures students, understanding of material	Rewards independent thinking	Accurately measures competence Student and teacher work towards goal and measure progress
Nature of knowledge	Is certain or absolute	Is Partially certain and partially uncertain	Is uncertain-everyone has own beliefs	Is contextual; judge on basis of evidence in context

Source: (Richardson, 2001)

2.13 CONCLUSIONS

In this chapter, the original work of Perry has been described and various adaptations outlined. It has been noted that there have been few empirical studies relating to the Perry stages. However, one major study did show that a major curriculum re-structuring (from traditional to a problem-based approach) did produce major changes in student perceptions. The advantage of the Johnstone's adaptation is its simplicity and accessibility. Because of this, this approach will be adopted in this study.

A number of writers have made suggestions about ways to encourage student development in terms of Perry positions. In the light of these, the ideas of group work and problem-based activities seem to have potential, particularly involving themes, which allow students to work with open-ended situations. It is, therefore, appropriate to look at what is known about this kind of learning situation and this is the theme of the next chapter.

CHAPTER THREE

CHAPTER THREE
PROBLEM SOLVING

3.1 INTRODUCTION

Problem solving is used every day in our lives (Fisher 1995, Reid & Yang 2002). Dealing with a flat tyre, searching for a new computer and finding a good school for your children are all typical problems in our lives. Most educators consider problem solving as one of the most important outcomes of their teaching (Gagné *et.al.*, 1993). Hodson (1998) argued that problem solving is important in that allowing students to undertake their own investigations contributes significantly to their understanding of the nature of science. Reid and Yang (2002) suggested that life could be considered as problem solving process. Johnstone (2001) goes further and suggests that human beings exist because they are already competent problem solvers. However, that does not mean mistakes cannot happen while we trying to solve our problems but all normal human beings are quite good problem solvers in general.

Garrett (1989) pointed out that problem solving is one way in which many modern science courses seek to enhance creativity. However, creativity cannot really be enhanced by using the kinds of problems which are typical of most science classes. This is because most of these cannot really be considered as problems. They are either exercises or scientific puzzles where there are, in most cases, single answers. To encourage the creativity of our students we should teach them by using open-ended problem solving where there are many possible answers to the problem. The idea of absolute success or failure needs to be changed to a more realistic conception where appreciation is given to the relative ability of solving problems.

Reid & Yang (2002) argued that most of real life problems are ill-defined. Furthermore, Glover *et. al.* (1990) stressed that most significant real-world problems are not only ill-defined but tend to be multi-faceted and open ended. However, the majority of problems which are taught in schools tend to be well-defined. In these problems, all of the necessary data is given, no superfluous data is provided, the method is familiar and the goal is explicitly stated.

To make problem solving more beneficial learners should be involved actively and take some responsibility for the problem before they can arrive at a solution. As Watts (1994) stressed, effective learning is active learning. He described active learning as *"when the learner takes responsibility for what he or she wants to learn – making decisions about the 'what' and the 'how'"*.

This chapter will cover different aspects of problem solving because problem solving is one of the main ideas used in this study the building of teaching materials (to be called teaching units) to promote intellectual development. These teaching units are attempts of challenging students to become active problem solvers in order to change their perceptions of learning positively.

3.2 **WHAT IS PROBLEM SOLVING**

In a dictionary of education (Lawton & Gordon, 1996), problem solving is defined as *"a style of teaching or learning where the aim is to encourage pupils to acquire knowledge and skills in the process of solving problems rather than simply learning about how other people have solved such problems"*

Gagne` (Kempa and Nicholls, 1983) defined problem solving as:

"a process by which the learner discovers a combination of previously learned rules that he can apply to achieve a solution for a novel problem situation"

Two main points can be concluded from this definition. The first point is that previous knowledge is important in problem solving and the most important knowledge is the "previously learned rules". Secondly, it is important to use these rules to find a solution to new situations. However, those two definitions do not give a clear definition of problem solving. In both definitions, problem solving was used to define problem solving. There is a need for a more precise definition.

Schon (Chin, 1993) tried to make this clear when he defined problem solving as:

"knowing what to do when you don't know what to do"

Bowen and Bodner (1991) defined problem solving in a similar way:

> *"....figuring out what to do when one does not already know what to do"*

Gayford (1989) saw problem solving as:

> *"part of the process of investigation where the solution is not obvious to the investigator at the outset of the activity"*

Frazer (1982) defined problem solving as bridging the gap between the problem and its solution or solutions, or overcoming the obstacle or barrier in the path from problem to solution. From all these definitions, it can be concluded that problem solving is a learning process where the learners move from one point to another without initially knowing how to move between them.

3.3 WHAT IS A PROBLEM?

There are many definitions for problem. For example, Fisher (1995) defined a problem as:

> *"a task with a certain number of given conditions and items of information. It has a context, although the relevant factors which make up the given context may not be at all clear. The person confronting it wants or needs to find a solution"*

Hayes (1981) stated that, *"A problem exists when a person perceives a gap between where he or she is and where he or she wants to be but doesn't know how to cross the gap"*.

Fisher (1995) insisted that real life problems are ill-defined and multi-faceted. Because of this, there is rarely a single or final answer. What a person tries to find in that situation is the best way or approach to come up with best-fit answer or answers. These problems can be called open-ended problems (Fisher, 1995). In these kinds of problems there is often more than one right answer. However, a close examination of real science problem solving may lead us to suggest that many problems are open-ended. Different scientists try different approaches to solve these problems and they will try to find as many solutions as they can.

Fisher (1995) considers that most problems taught at schools are closed, where the problem and the way to solve it are well defined and will lead to one right answer for each problem. The reality supports Fisher and that might not help in encouraging our students to think creatively since this way is far away from the reality. Students need to realize that there are different perspectives and options to tackle a problem.

According to Gagné *et.al.* (1993), a problem exists whenever one has a goal and has not yet identified a means to reach that goal. Ausubel and Robinson 1969) gave a similar definition when they defined a problem as *a gap between what the student currently knows and what he is required to find out.*

Several authors (Lale & Robinson, 2001, Reid & Yang, 2002) have distinguished between what can be called a problem and what is called an exercise. Lale and Robinson (2001) stated that *"an exercise is a problem that we know how to solve from the beginning",* whereas the real problem is ill-defined where you do not know how to solve it from the beginning. Most of what is taught in schools and universities as problem solving is no more than exercises. This is because in these cases students have been taught how to solve these problems from the beginning.

3.4 PROBLEMS TYPES

Many people have tried to categorise problems into different types. One of those is Reed (1988), who categorised problems into three types according to the general skills and knowledge needed to solve them: *arrangement, inducing structure and transformation.* However, this does not imply that all problems can be fitted only into one of these types. It could be that a problem fits into more than one category.

Reed (1988) defined *arrangement problems* as those which present some objects and require the problem solver to arrange them in a way that satisfies some criterion.

There may be more than one solution. He also pointed out that skills required to solve arrangement problems are:

a. Fluency in generating possibilities.
b. Retrieval of solution patterns.
c. Knowledge of principles that constrain search.

Solving this type of problem may include a process of trial and error.

In *inducing structure problems*, the relationship between objects is fixed and the problem is to discover it. Some objects are given and the task is to find how they are related. Reed (1988) thinks that some common skills are included in inducing structure across different tasks.

In *transformation problems*, initial state and goal state along with a sequence of operations for changing the initial state into a goal state are given.

Another way to categorise problems is to put them into two main categories: well-defined and ill-defined problems (Kahney, 1986). In well-defined problems students are provided with four sorts of information (Kahney, 1986): initial state of the problem, goal state, legal operators (which are defined as things you are allowed to do in solving the problem) and oprerator restrictions. Most of real life problems are ill-defined whereas the majority of problems in schools are well-defined.

Problems can be divided into closed problems and open-ended problems. In closed problems, there is always one right answer. In open-ended problems, there are different answers for a problem and the learner's task is to find the best answer or answers. Again, here most of problems taught in schools are closed problems (Sleet *et al*, 1987). By always concentrating on the closed problems, we are perhaps encouraging our students to be convergent thinkers. Furthermore, this may encourage the idea of absolute success or failure.

Johnstone (1993) put all these ideas together in a very useful classification. He classified problems into eight types as it shown in Table (3.1). Johnstone classified problems according to three variables: the data provided, the method to be used and goal to be reached.

Table 3.1 Classification of Problems (Johnstone, 1993)

Type	Data	Methods	Goals/)utecomes	Skills Bonus
1	Given	Familiar	Given	Recall of algorithms
2	Given	Unfamiliar	Given	Looking for parallels to known methods
3	Incomplete	Familiar	Given	Analysis of problem to decide what further data are required
4	Incomplete	Unfamiliar	Given	Weighing up possible methods and then deciding on data required
5	Given	Familiar	Open	Decision making about appropriate goals. Exploration of knowledge networks
6	Given	Unfamiliar	Open	Decisions about goals and choices of appropriate methods. Exploration of knowledge and technique networks
7	Incomplete	Familiar	Open	Once goals have been specified by the student, these data are seen to be incomplete
8	Incomplete	Unfamiliar	Open	Suggestion of goals and methods to get there; consequent need for additional data. All of the above skills

Johnstone (2001) argued that type 1 is what commonly is called a problem in school and higher education. In this type of problem, all necessary data are given, the method is familiar and the goal is clearly stated. Johnstone, like others, does not consider this a problem. It might be called an exercise. Reid & Yang (2002) note that types 1 and 2 are widely used in textbooks and examinations paper. In type 3, the data is not all provided whereas in type 4 the method is unfamiliar and data are not complete. Johnstone never argued that his analysis was hierarchical; thus, it does not necessarily mean that problems type 3 and 4 are more complex than types 1 and 2. Type 8 was seen as a nearest to real-life problems (Yang, 2000) but this does not mean necessarily they are the most difficult problems. Overall, these eight types are not a hierarchy in terms of difficulty but they are just different types of problems.

A careful look at the Johnstone classification may suggest that his includes some of the other classifications. For example, Johnstone differentiates between what can be called a problem and what can be called an exercise. He considers type 1 as an exercise rather than a problem. Johnstone's classification also includes the classification of problems as open ended and close-ended problems. In his classification, the goals or outcomes of some types of problem are open. Finally, it is clear that some types of problems in Johnstone classification can be called well-defined problems where is the others are ill-defined problems.

3.5 PROBLEM SOLVING AND THE BLOOM TAXONOMY OF THE COGNITIVE DOMAIN

Bloom (Bloom, 1956) devised a taxonomy for educational objectives. This taxonomy covers three main domains: cognitive domain, affective domain and psychomotor domain. This section will focus on the relationship between problem solving and the cognitive domain. Bloom divided the cognitive domain into six cognitive skills: knowledge, comprehension, application, analysis, synthesis and evaluation. One of the key advantages of Bloom's taxonomy is the highlighting of these six skills which are important for the learner. Teachers should cover all these skills in their teaching in order to enhance students' thinking. Bloom put these six skills into an hierarchy as it is shown in figure 3.1

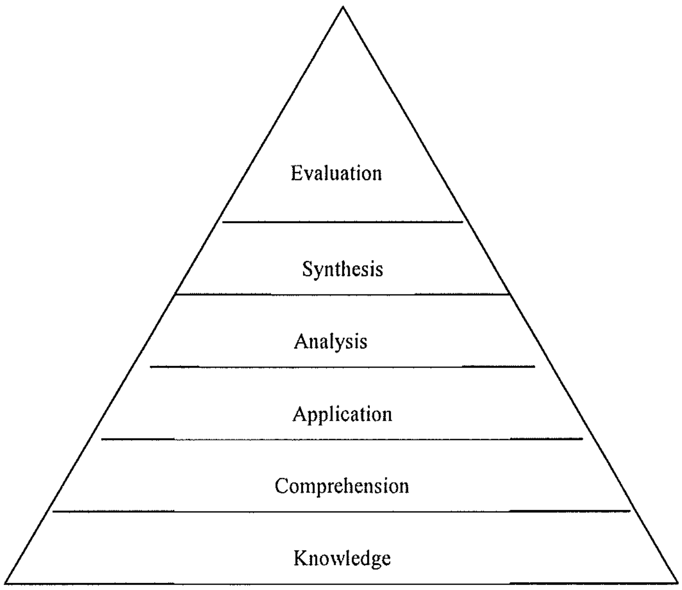


Figure 3.1: Bloom's taxonomy of cognitive goals

Source: (Fisher 1995)

Garratt (1998) defined all these skills as they are shown in table 3.2. The top three skills on Bloom's taxonomy are called "higher order skills". These three are very important for solving non-algorithmic problems (those described as exercises or type 1 of Johnstone classification). According to Bloom, problems which require analysis and synthesis are more difficult than problems requiring only comprehension.

Table 3.2: Skills of Bloom's taxonomy

Skills	Definitions
Knowledge	Able to identify and defined the concept
Comprehension	Able to apply the concept when instructed
Application	Able to apply concept appropriately without instruction
Analysis	Able to dissect a problem and apply the appropriate concept
Synthesis	Able to combine concepts in new and appropriate ways to give new useful knowledge.
Evaluation	Able to analyse a problem in multiple ways and to identify the relative strengths and weaknesses of each approach

Bloom designed his taxonomy in an hierarchical way. However, there is an alternative way to look at the Bloom taxonomy figure 3.2.

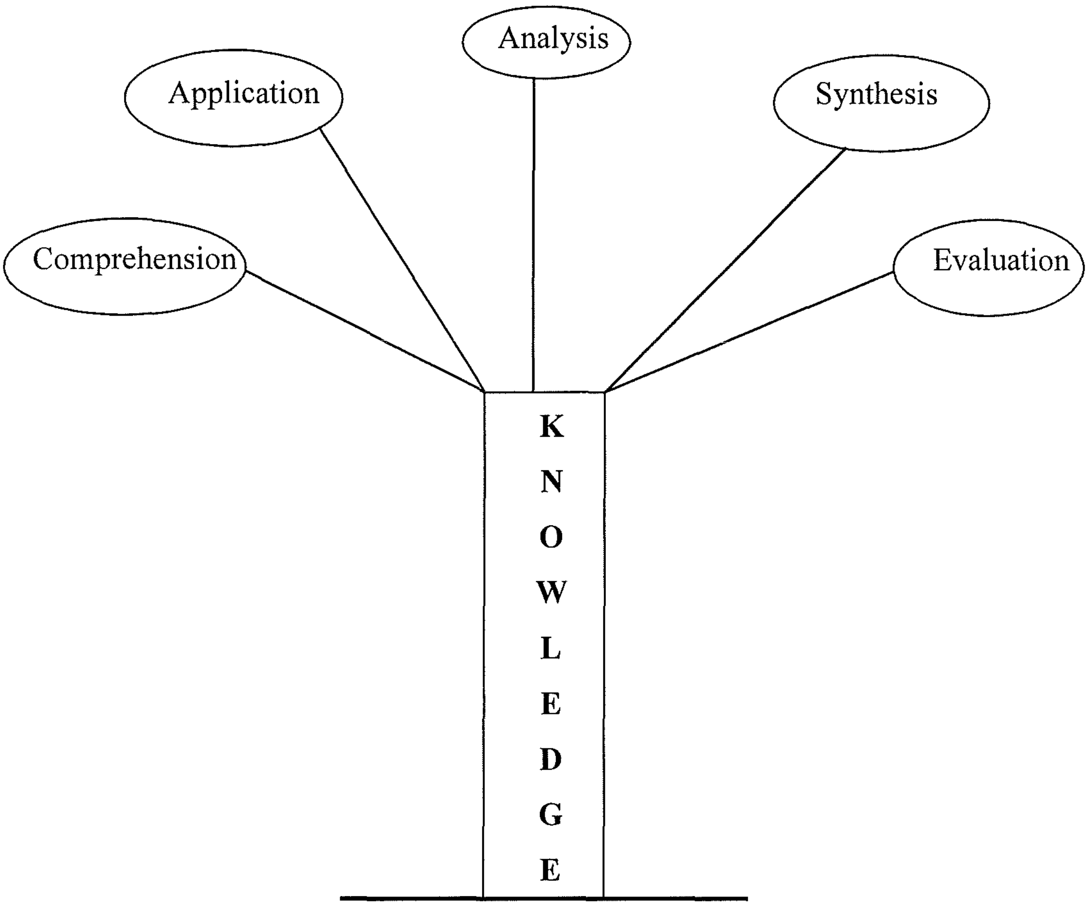


Figure 3.2: An Alternative Model of Bloom's Taxonomy

In this model, skills are not hierarchical. Instead Knowledge is regarded as the basis for all other five skills. In the original Bloom taxonomy, analysis is thought to include the skills below it. In the alternative model these skills are not related in this way to each other. Instead, knowledge is seen as essential for all other skills. For example, a student can synthesise without necessarily applying or analysing but he cannot apply do any of other the five skills without knowledge (known or provided).

Yang (2000) argued that this modification of the Bloom's taxonomy helps us to describe problem solving. For example, the open ended, real-life problems can be thought of as one or more of analysis, synthesis and evaluation without using application whereas algorithmic problems can be thought of as an application. In applications, students are applying some learned procedures using new data. The real question which may be asked here is whether to consider algorithmic problems as problems at all. Taking into account the Johnstone classification of problems (see table 3.1), it can be concluded that algorithmic problems cannot really be considered as problems but as exercises. Since in algorithmic problems, data are given, methods are familiar and goals are given, they are not real problems. They are exercises rather than problems. From all this, it is possible to suggest that the most important skills for problem solving are analysis, synthesis and evaluation.

3.6 THE FACTORS INFLUENCING SUCCESS IN PROBLEM SOLVING

Many people have tried to discover the factors influencing success in problem solving. Among these are Gabel and Bunce (1994). They argue that problem solving is influenced by three factors:

(1) *The nature of the problem and the underlying concepts on which the problem is based:* it includes the problem style and conceptual understanding.

(2) *Learner characteristics:* it includes the individuals' cognitive styles, developmental levels and their knowledge base.

(3) *Learning environment factors:* it includes problem-solving strategies/methods, individual or group activity.

Charles and Lester (1984) suggested three sets of factors (see figure 3.3) which interact with each other:

(1) *Experience factors, both environmental and personal*

(2) *Affective factors, such as interest, motivation, pressure, anxiety, and so on*

(3) *Cognitive factors, such as reading ability, reasoning ability, computational skills, and so on*

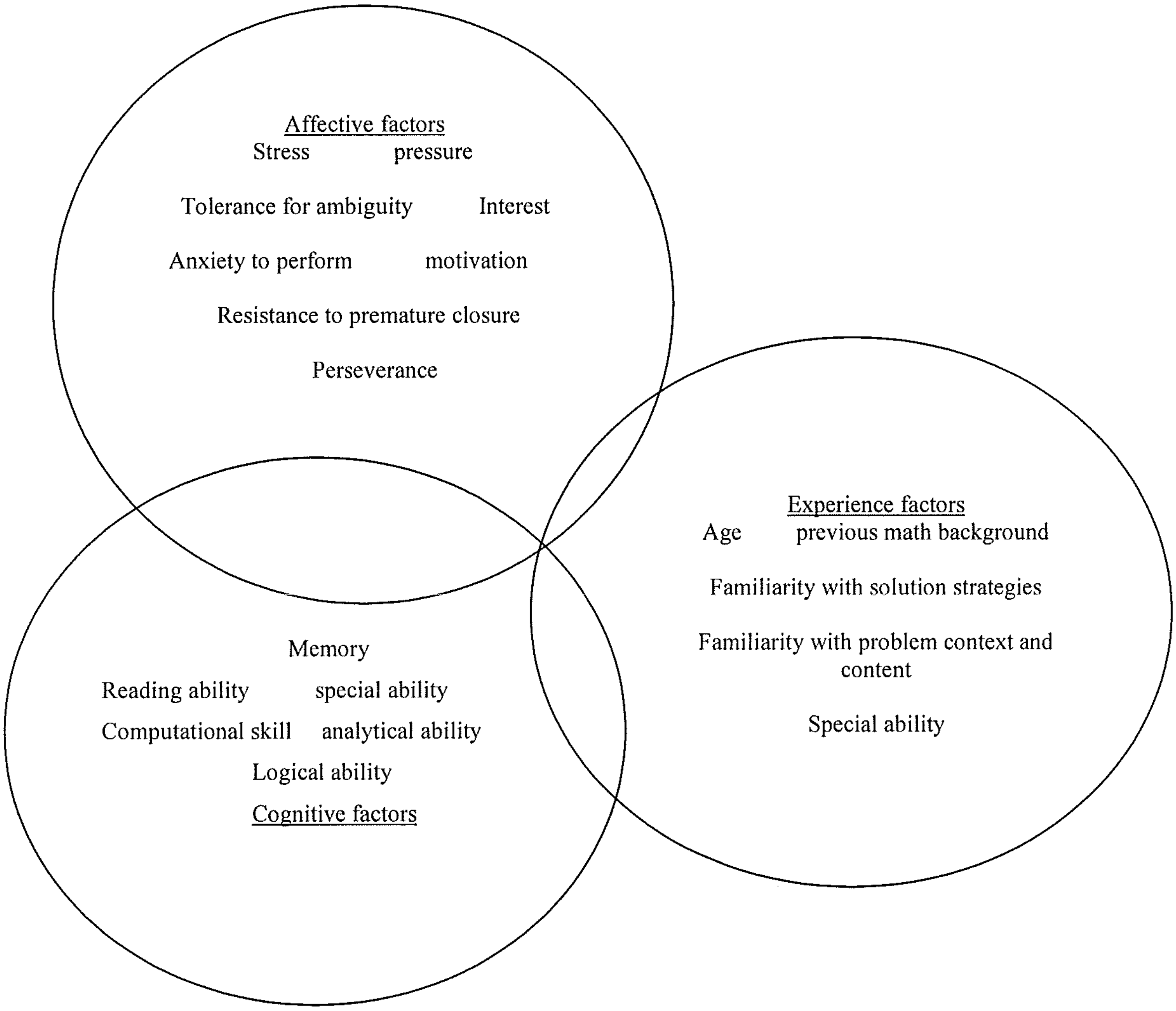


Figure 3.3: sets of factors that influence the problem solving process

Source: (Charles and Lester, 1984)

Ausubel and Robinson also (1969) suggested some factors which might influence problem solving. They divided these factors into two main groups: task factors and intrapersonal factors. Among task factors are practice with a variety of problems, heterogeneity of exemplars, forcing the subject to remain alert and attentive, increasing generality. Intrapersonal factors include intelligence (this is because reasoning power is a prominent component of intelligence tests (Ausubel & Robinson, 1969)), intellectual abilities (comprehension, memory, information processing, ability to analyse), cumulative incidental experience, cognitive style, motivational traits and temperamental and personality traits. Lyle and Robinson (2001) argued that experience is vital in helping students to develop efficient and effective problem solving skills and strategies that generally guide towards successful solution of true problems. They also argued that it is very important for instructors to know about effective instructional methods to help students gain these skills and strategies. For them the best way to help students to be good problem solvers, is to combine their previous knowledge with their skills.

An analytical look at all these factors, suggests that we can control some but we cannot do much with others. Furthermore, all these factors are really very similar but different people use a different language to describe them, and this can lead to confusion and fruitless discussion.

3.6.1 Prior Experiences and Successful Problem Solving

Knowledge is essential for human cognition. Many studies (Ashmore *et al.*, 1979; Frazer & Sleet, 1984; Waddling, 1988) showed that prior problem experiences are important to determine successful problem solving. According to Reid and Yang (2002), prior experience includes prior knowledge and emotional experience related to the problem solving area. Johnstone (2001) pointed out the same thing and he added that previous knowledge and experience laid down in memory allow new connections to be made.

Ashmore *et al.* (1979) used a problem solving network approach to illustrate the interconnection of pieces of information and to specify all information required to solve problems. From their study, Ashmore and colleagues found that a combination of a strong background knowledge, knowledge of problem solving strategies and tactics and confidence is necessary for chemical problem solving.

Previous knowledge is essential for solving problems (Glover *et al.*, 1990; Sleet & Shannon, 1988). However, that does not mean that, if the student has all the needed knowledge, he will necessarily be able to solve problems based on that knowledge. Many studies (Sumfleth, 1988; Shaibu, 1992; Adigwe, 1993; Lee *et al.*, 1996) have shown that, even if a student has all the required knowledge, he may still fail to solve the problem.

3.7 INFORMATION PROCESSING MODEL AND PROBLEM SOLVING

Many people have tried to find out the answer to the question " how do humans learn?". Among these are Piaget (Piaget & Inhelder, 1969), through his theory of cognitive development, who saw learning as an active process which happens because of interaction with the environment. Vygotsky (1974) thought that a learner can do slightly better than the level indicated by Piaget's stages of development. Bruner (1986) thought that learning is an on-going process which is influenced by previous experiences/knowledge and social environment of the learner while Ausubel (1963) claimed learning happened through a meaningful learning process of relating new events to the already existing cognitive concepts or propositions.

The development of information processing models grew out of the ideas from many of these early educational researchers. The information processing model is another effort to throw light on the processes by which humans learn. Information processing models initially used metaphors borrowed from the artificial intelligence science which is a branch of computer science (Christou, 2001). These models are intended to illustrate how humans process, store and retrieve the information received from the senses. A considerable amount of research literature has developed which has demonstrated strong evidence of the predictive validity of the information processing model (Johnstone, 1997b; Chandi, 2003)

There are many information processing models in the psychology literature. Most of these models have been influenced by the work of Atkinson and Siffrin (1971). Johnstone (1993) proposed an information process model (figure 3.4), which suggests a simplified mechanism of the learning process.

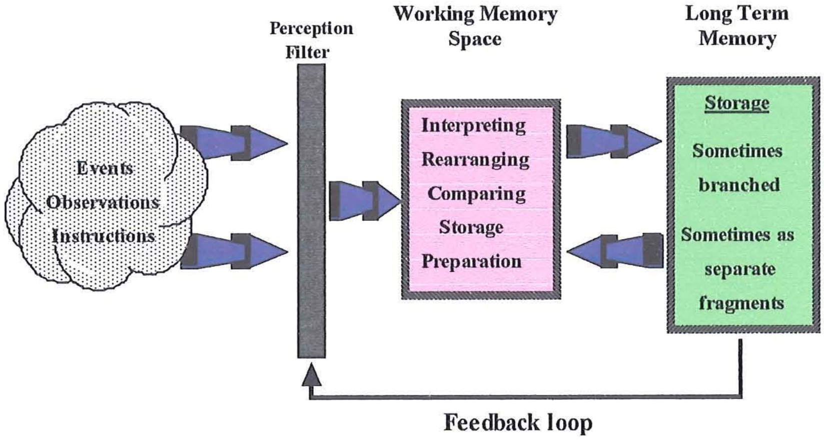


Figure 3.4 Information Processing Model

Ashcraft (1994) divided the modal model of human memory into three types of information stages:

- The sensory memory
- The short-term memory
- The long –term memory

In Johnstone's model, sensory memory corresponds to the perception filter and short-term memory to working space memory (figure 3.4). Each of these is now described in turn.

3.7.1 Sensory Memory – Perception Filter

Sensory memory consists of sensory registers. These sensory registers are linked to the five senses: sight, hearing, taste, touch and smell. Through sensory registers, we interact with our environment to receive information from it. Research has focused on vision and hearing sensory registers. Ashcraft (1994) illustrated two types of sensory memory:

- Visual sensory memory ⟶ receive visual stimuli
- Auditory sensory memory ⟶ receives auditory stimuli

Neisser (1967) called the visual sensory memory, the *iconic* memory and auditory sensory memory the *echoic* memory.

Information can be held for a very short time in iconic memory. It can be held for one quarter to one half of a second whereas in echoic memory it is held no more than two or three seconds (Ashcraft, 1994).

The sensory memory system can be considered as a very limited system. This is because it holds information for a very short period and it responds only to a certain amount of information. We receive a huge amount of information at any time and it is very difficult to respond to all of it. We only respond to part of all available stimuli. It seems that all this information passes through a filter. White (1998) points out that the selection of events is crucial in learning and what is selected is affected by the learner's previous knowledge, attitude and abilities.

Johnstone (1993) in his information processing model called the sensory memory the perception filter (figure 3.4). The process of selecting information is called perception. The working of the perception filter is influenced by the long term memory. Previous knowledge, preferences, experiences, and prejudices control the perception filter and, because of that, attention is only given to certain stimuli. The selected information comes through the perception filter and goes to the working memory where manipulation can take place.

3.7.2 Short-term Memory or Working Memory

Some authors call this memory space short-term memory (STM) (Bruning *et al*, 1995; Reed, 1988; Ashcraft, 1994; Atkinson & Siffrin, 1971) whereas others call it working memory (Gagné *et al*, 1993; Richardson, *et al*, 1996; Baddeley, 1986; Johnstone, 1988). The important thing to notice is that there is a memory space of limited capacity which can be used to hold information and process it. If only holding is involved, the space can be called short term memory. If processing is also involved, it is called working memory space. In the discussion that follows, the phrase used by the relevant author concerned will be used although it has to be recognized that this can be very confusing. Johnstone (1984) defined working memory as *"that part of the brain where we hold information, work upon it, organise it, and shape it, before* *storing it in the long term memory for further use".* For example when we memorise a set of names and then we try to recall them within seconds, this process happens in our short-term memory.

Short-term memory has two characteristics. The first is that it has a limited space for storage. Miller (1956) founded that the average capacity is about seven and that most have working memory spaces which have a capacity of seven plus or minus two (7 ± 2) separate "chunks" of information. Fontana (1995) stressed the same thing. Other literature referred to units of information instead of chunks (Gagné *et al*, 1993). The most important thing is the meaning of the term rather the term itself.

From reading the literature, the two terms chunks and units seem to be used interchangeably and mean the same thing. However, in this study *chunks* of information will be used. Chunks are defined as (Danili, 2001) *"parcels of information, the size of which is in the control of the learner. It might be a single number or a single letter or many pieces of information grouped together".* For each person, there is a fixed number of chunks that can be held in the working memory. Moreover, by the process of chunking, working space capacity can significantly increase because the learner can arrange items in groups of data rather than storing them individually.

The second characteristic of the working memory is the short time that it can hold items (hence *short term* memory). Murdock (1961) claims that the information can be held in the short-term memory for about 10 seconds unless it is rehearsed. Brunning *et al.* (1995) argues that information can be held in the short-term memory for about 20 seconds without continued rehearsal. However, if it is 10 or 20 seconds, it is still a short period of time. On the other hand, it is clear that rehearsal has significant role in enhancing the period of holding the information in the short-term memory. Peterson and Peterson (1959) showed that short-term memory was dependent on rehearsal and repetition.

Johnstone (1997a) pointed out two main functions of the working memory space. First is to hold ideas and facts while we are thinking about them. The new information which is coming through the perception filter interacts with itself and with information coming from long-term memory in order to make sense. The second function is to provide a transition between the perception filter and long-term memory. Working memory space holds the processing activities to get information ready to be stored in the long-term memory. If there is too much information to be held in short term memory, they may be not enough space for processing. This may lead to overloading of the short term memory.

Johnstone (1999) pointed out that overloading happens if there is too much to hold in working memory. Because of this, they will be no space for processing. On the other hand, if much processing is required, little information can be held. During overload, students are unable to hold all the information and lose the direction of what they are asked to do.

Overload can happen in the laboratory or a lecture, depending in the way these are conducted. Johnstone and Wham (1982) showed that overload in working memory happens when the learner cannot distinguish what they called the 'noise' from the 'signals'. Noise was used to mean non-essential and irrelevant information that the teacher is transmitting to learners while signal was used to describe the essential and useful information.

3.7.3 Long-term Memory

The main difference between sensory, short-term memory and long-term memory is that the first two include information recently experienced while the long-term memory involves the permanent storage of information which is accumulated over time (Bruning *et al*, 1995). For example, when someone wants to remember his name, he recalls it from his long-term memory - it has been there for long time. Long term memory is also apparently unlimited, not easily disrupted and indefinite. Furthermore, it is relatively stable and long lasting. Johnstone *et al.* (1994) described it as a large store. Solso (1995) also argued that the long-term memory has unlimited capacity and its duration is virtually endless.

There are many attempts in literature to categorise long-term memory. Tulving (1986), for instance, pointed out that long-term memory has two components: episodic and semantic memory. Episodic memory is the individual's autobiographical records of previous experience whereas semantic memory is the memory of meanings (language, rules and concepts). Another attempt was introduced by Anderson (1982) and Squire (1987). According to them, long-term memory can be divided into: the declarative and the procedural long-term memories. Declarative memory holds 'knowing of what' such as names, description of acts and meanings of word. In the other hand procedural memory holds 'knowing how', such as how to drive. In general it holds information about how to perform certain activities.

The transfer of material from short-term memory to long-term memory needs concentration. This requires encoding of information which means transforming the information and representing it in another way. Information can be encoded into:

(a) the verbal coding system which is linguistically adapted information.
(b) The imaginal coding system which is adapted for non-verbal information such as pictures and sound.

Paivio *et al.* (1988), in their dual coding theory, argued that information can be coded using one or both systems. They also pointed out that, by using the two systems to encode, memory will be enhanced.

In the long-term memory only the potentially important, interesting or useful information is received. At the same time, unimportant or irrelevant information is ignored. We make sense of the new information by seeking patterns through connecting the new information with the existing information the long-term memory. According to Johnstone (1997a), new information is discarded when it does not make sense. The process of storing information in long-term memory is personal and memory uses a variety of functions such as: pattern recognition, rehearsal, elaboration, organisation. Johnstone (1997a) suggested ways of storing:

- *The new knowledge finds a good fit to existing knowledge and is merged to enrich existing knowledge and understanding (correctly filed).*
- *The new knowledge seems to find a good fit (or at least a reasonable fit) with what existing knowledge and is attached and stored, but this may, in fact, be a misfit (a misfiling).*
- *Storage can often have a linear sequence built into it, and that may be the sequence in which things were taught.*

- *Memorization which occurs when the learner can find no connection on which to attach the new knowledge.*

The first way of storing is linked to the meaningful learning whereas rote learning occurs in the last way of storing. The second way can lead to misconception or alternative conception.

3.7.4 The Relationship Between the Problem Solving and the Information Processing Model

Information processing ideas are now well established with a very considerable amount of empirical support (eg. Johnstone, 1997b). Having looked briefly at information processing ideas, the relationship between problem solving and information processing will now be discussed.

Sleet (2003) argued that it is very important to explain the role of our memory in problem solving for learners before explaining the strategies for problem solving. This is very important for the learners in order to appreciate the implication of the learning experience and techniques which are planned to improve their problem solving abilities.

In problem solving, new information and the nature of information have to be taken into the working memory space and the selection of what is taken in is influenced by what is already held in the long-term memory. It seems that, according to the information processing model, it is better for students to solve problem within groups rather than do it individually. Johnson and Johnson (1975) pointed out that problem solving is an inherently cooperative process. People concerned with everyday problems tend to solve them with others. Perez and Torregrosa (1983) supported the idea of dividing the class into small groups during problem solving especially when the problem is set up as investigation task rather than a simple exercise. This may lead us to suggest that in order to help our students to be good problem solvers, we need to help them to learn how to cooperate with their peers. Slavin (1983) thought that small groups are the best way to promote students participation in tasks. Qin *et al.* (1995), in their review of many studies, showed that cooperation rather than competition promoted success in nonlinguistic problem solving. In general, cooperative group work helps students to solve problems. This may be explained in terms of the opportunity for students to share expertise and insight with others which may produce a variety of strategies to solve problems, increased ability to translate the problem statement into questions.

This can also be explained according to the information processing model. When a student deals with problems individually, he uses only his own previous knowledge and working memory space. If he does not have enough previous knowledge or his working memory space is overloaded, he might not be able to solve the problem. On the other hand, when working with groups to solve problems, students can share their previous knowledge and can use their working spaces together to come up with the solutions. In this study, problem solving will be used to help students to change their perceptions of learning. Students will be working within groups in order to solve these problems. Furthermore, it will help our students to use their working memory effectively. Sleet and Shannon (1988) argued that students' abilities to solve problems can be improved if they are encouraged to represent problems effectively by removing the key information from the irrelevant information and make the relationships among the given data more clear.

Long-term memory and working memory have important functions in solving problems. With regard to long-term memory, Sleet (2003) pointed out that the solution to chemical problem requires specific prerequisite chemical skills and knowledge. However, this is true for all sciences. On the other hand, it does not mean that having all the prerequisite knowledge and skills in long-term memory is sufficient for all students to be able to solve problems. Good problem solvers need to have the ability and or motivation to recognize the need to apply skills stored in their long-term memory. Quick recall of the knowledge from long-term memory is essential for good problem solving (Sleet, 2003). It is vital to help students to develop their ability to recall quickly knowledge from the long-term memory. If students are encouraged to store information meaningfully, this will mean that they have developed a network of links and the recall process will be easier.

In the information processing model, previous knowledge is used to process external information by relating new information to what is already known. In problem solving, previous knowledge is used to interpret the new information and to specify the goal of the problem. When a new problem is given, the long-term memory term memory is searched for the schemas that contain specific strategies and knowledge related to that problem. If the problem is familiar, then it may be that one cycle of interpretation is enough to come up with the solution (Lyle & Robinson, 2001). However, can a problem which is this familiar really be called a problem? Perhaps, it is more an exercise than a problem. With genuine problems, the situation is more complicated and it may need more than one cycle of interpreting, representing, planning, execution and evaluation (Lyle & Robinson, 2001). Finally after the problem is solved, new information may be stored in the long-term memory as a result of solving of the problem.

With regard to working memory, Sleet . (2003) argued that students should be helped to develop the ability to make more efficient use of working memory. This can be done by teaching students to:

- *"structure information so that the load on their WM can be reduced.*
- *increase the total amount of information that they can co-ordinate simultaneously in their WM."*

This assumes that it is possible to teach such skills. It is obviously possible for teachers to structure information to reduce working memory demand. However, it is not possible to modify a student's working memory space and it appears very difficult to teach students how to 'chunk'.

3.8 GENERAL PROBLEM SOLVING STRATEGIES

Reed (1988) argued that knowledge of general problem solving strategies is very important and helpful for students. Sleet *et al.* (1987) argued that it is very important to teach students procedures that will help them to develop a plan to solve the problem. However, in several empirical studies with both school pupils and university students, Bodner (2003) and Yang & Reid (2002) showed that students never planned their problem solving, even when encouraged to do so. Bodner also demonstrated that most proposed problem solving plans were incapable of operation. However, there may be general strategies which may help students to solve problems: (Gagné *et al*, 1993), means ends analysis and subgoals (Reed, 1988).

Polya (1945) is one of the earliest to propose a problem learning. It consisted of four steps: *(1) Understanding the problem (2) Devise a plan (3) Carry out the plan (4) Look back.* Roe *et al.* (1989) also suggested a strategy to introduce problem solving to the teacher's class. They put their strategy in five steps: *(1) identifying a problem (2) obtaining information related to the problem (3) forming hypotheses (4) testing the hypotheses and forming a conclusion (5) applying the solution and evaluating its effectiveness.* Sleet *et al.* (1987) also pointed out a strategy which consisted of three main stages to solve closed problems: *(1) Representing or defining the problem (2) Devising a plan and Solving the problem (3) Checking and reviewing.* These three stages are split into nine steps as it is shown in Table 3.3.

Table 3.3: Sleet *et al* strategy to solve close problem

Stages of problem solving	Steps for problem solver
I. Representing or defining the problem.	1. Draw a diagram, graph or table. 2. Summarize given information with appropriate notation. 3. Restate problem or needed information in appropriate notation.
II. Devising a plan and solving the problem.	4. Working from your representation of the problem. 5. Check to see if problem is an example of a standard type of problem. 6. If problem is unfamiliar, work back from goal, by asking the question, 'what do I need to know or be able to do in order to complete this step?' 7. If unsuccessful with above steps try the following: (i) try to convert all or part of the problem to a more familiar one (ii) brainstorm (iii) guess at solution and see if it is consistent with given information (iv) go back to problem and consider another representation – look for any hidden assumptions.
III. Checking and Reviewing	8. Check the units, sign and magnitude of any calculated quantity 9. Review solution and learn from it

The strategy of Sleet *et al.* (table 3.3) seems to be very complicated and not easy to follow. However, he argued that these strategies help students to solve problems because they help students to reduce the load in their working memory, which results in the effective use of their working memory. Through these steps students focus on the key information stated in the problem. By comparing these strategies we notice that the general approach in all of them is almost same. The only difference is in the details. All of these strategies are given great importance in defining the problem. This is because without doing that any attempt to solve the problem may fail.

Hayes (1981) suggested two types of representation when students try to understand a problem: *internal* representation and *external* representation. Simon and Simon (1978) defined internal representation as *"information that has been encoded, modified and stored in the brain"*. External representation was defined as *"physical manifestations of this information"* (Bodner & Domin, 2000). External representation can be a sequence of words or a drawing to describe an internal representation. Larkin & Reif's (1979) study concluded that verbal or pictorial representations are influential tools for making the vital early decisions needed to plan the solution of problem solving. By using representations, students distinguish between relevant and irrelevant information.

Overall, while there are some general approaches which can assist students towards successful problem solving, there nor no detailed sequences of operations which are universally useful.

3.9 PROBLEM SOLVING TEACHING MATERIALS

Perry's approach to intellectual development is very much attitudinal in nature. Perry was looking at students' *perceptions* of their learning and, these may reflect their *attitudes* to learning. Considerable research has been carried out looking at ways which students' attitudes can be developed by means of curriculum modification (eg Johnstone and Reid, 1981). These studies have been shown very clearly that passive approaches do not encourage attitudinal development. Indeed, in the work described by Johnstone and Reid, they stress the vital importance of learners interacting with educational materials for attitudes to develop. They used what they called "interactive units". These were problem based teaching units where students worked in small groups to solve problems, which related to social themes based on fundamental science. Byrne (1985) continued the same idea to develop other more cognitive skills.

In the light of this evidence, the idea of using problem based teaching units where students work in small groups seems to offer considerable potential in any attempt to encourage intellectual development along the lines described by Perry.

CHAPTER FOUR

CHAPTER FOUR
EDUCATION SYSTEM IN THE SULTANATE OF OMAN

4.1. INTRODUCTION

This chapter presents an overview of the Omani education system to show the context for the study being described. This chapter will give the reader a brief idea about Sultanate of Oman. Then it will speak about the education system in Oman. In this part, the development of the education system and the structure of it will be discussed along with the others aspects of it.

Later, the initial teacher training in Oman will be described. The issues to be discussed will be initial teacher training in general, its development, and its structure. Finally, there will be a discussion of initial teacher training of science teachers.

4.2 SULTANATE OF OMAN

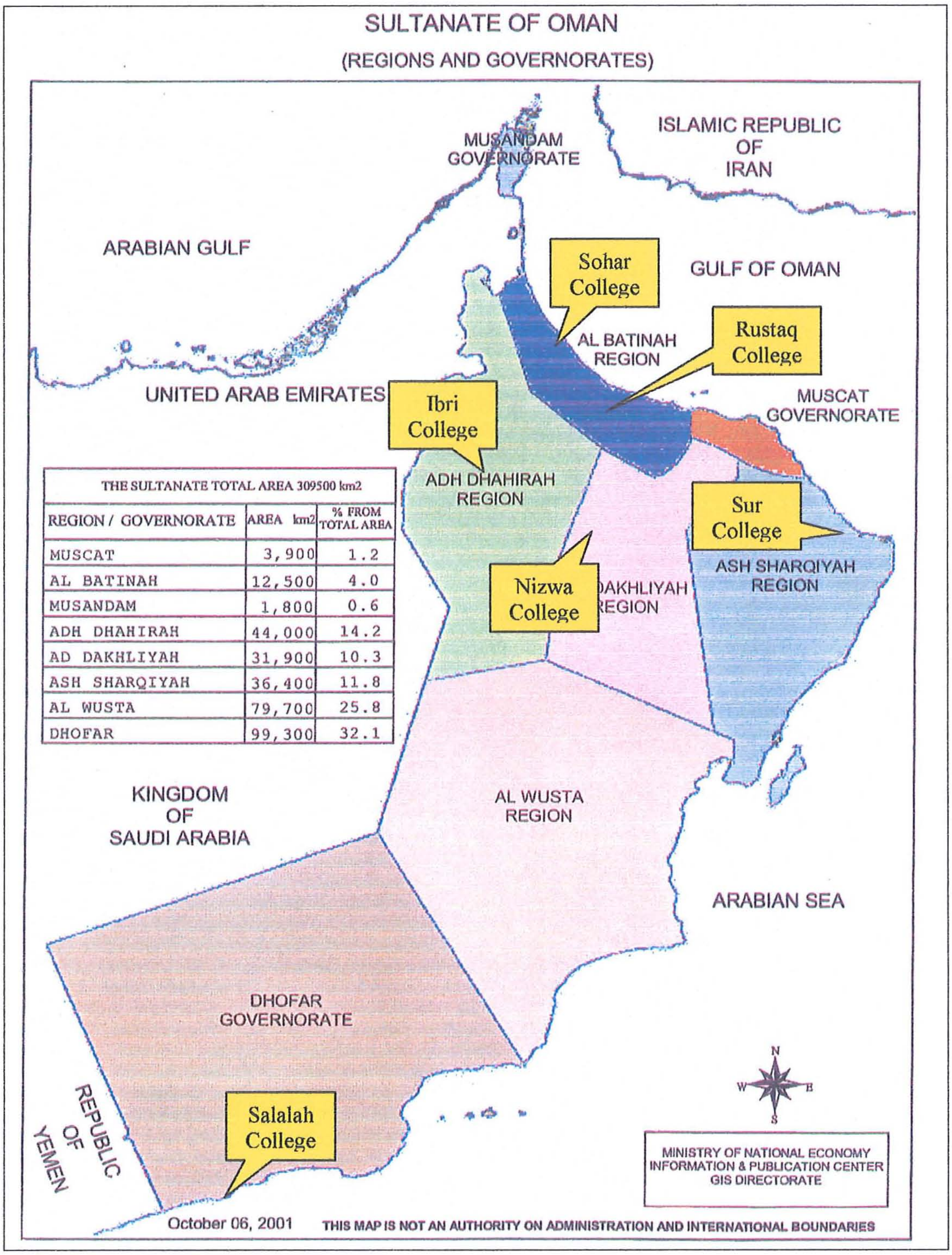
The Sultanate of Oman occupies the southeast part of the Arabian Peninsula. To the west Oman borders Saudi Arabia and the United Arab Emirates; to the south, the Republic of Yemen; to the north the Strait of Hormuz; and to the east the Arabian sea. With a total land of 309,500 km^2, Oman is the third largest country on the Arabian Peninsula. Oman has an extended coastline of about 1700 km from the Strait of Hormuz in the north to the Republic of Yemen in the south.

According to the Ministry of National Economics, the population of Oman was 2,018,074 in 1993. The mid-year estimate in 2001 was 2.48m (Ministry of National Economics, 2002).

4.3 HISTORICAL BACKGROUND OF EDUCATION

Like other Gulf States and before the development of the modern education systems, Kuttab education was the norm in Oman (Al-Busaidi, 1988). In kuttab schools, both boys and girls were taught the Quran and basic reading and writing skills (Al-Naibi, 2002). In some of these kuttab schools, elementary arithmetic was taught with the Quran and Arabic (Al-Busaidi, 1988). These kuttabs or Quranic schools were located in mosques, private houses and even under trees (Al-Hammami, 1999).

Figure 4.1: Map of Oman



Source: Ministry of Information web site (http://www.omanet.com/english/geo/map.asp)

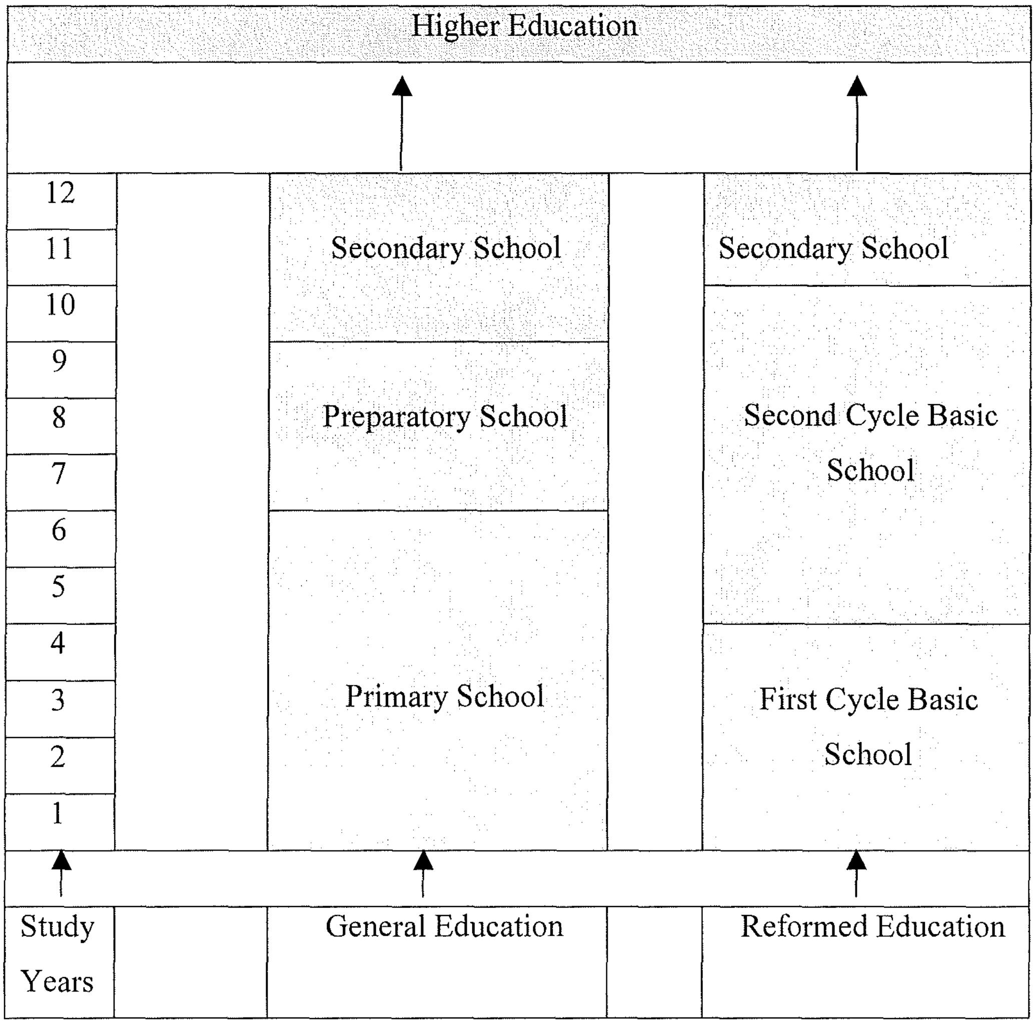
Before 1970, there were only three modern schools with a total of 909 students and 30 teachers (Ministry of Information, 1995). After His Majesty Sultan Qaboos came to power in 1970, a great priority was given to education and this started a period of rapid change. The number of schools dramatically increased, from 3 schools in 1970 to 1388 in 2003 (Ministry of Education, 2003). Students' number increased from 909 in 1970 to 639211 in 2003 (Ministry of Education, 2003). After 1970, the government took over the responsibility to educate all Omanis no matter what their gender or background (Al-Ghafri, 1996). However, the change was not just in the quantity. The quality of education was given enormous attention as well.

With that increase in education, a demand for teachers was created, and because there were few Omani teachers the great majority were expatriate Arab teachers. Many of them were Egyptian (Ministry of Information, 1995) and the need to train Omani teachers was recognized. The government set up many programmes to train Omani teachers. In general, over the 33 years, there has been a remarkable improvement in the field of education. A student now can continue his education from primary school up to University level entirely in Oman. Furthermore, some postgraduate courses have been set up in Sultan Qaboos University.

4.4 STRUCTURE OF EDUCATION SYSTEM IN OMAN

The education system in Oman (figure 4.1) consists of twelve years in school. Higher education includes the Sultan Qaboos University (SQU), the Colleges of Education, the College of Share'a and Law, Technical Colleges, and several private Universities and Colleges. The following few paragraphs illustrate the structure of the Oman education system, the general education and reformed education systems.

Figure 4.2: Education Structure in the Sultanate of Oman



At the moment, there are two parallel systems for schools in the Sultanate of Oman: the general education system and reformed education system. The Ministry of Education plans to replace the general education with reformed education gradually. In the following few sections, a brief overview of these two systems will be given to highlight some key points about these systems.

4.5 GENERAL EDUCATION

General Education in Oman is for twelve years (figure 4.1). Students start primary school at age of six. General education consists of three stages: primary (6 years), preparatory (3 years) and secondary (3 years). After finishing the first year of secondary education, students are divided into two streams: arts and science according to their choice. The medium of instruction is Arabic, the official language of the country. Starting from primary year four, English is taught as a foreign language.

4.6 REFORMED EDUCATION

In 1998 a reformed education system was introduced (Ministry of Information, 2001). The reform started with 17 schools. Two main reasons were behind this reform (Al-Naibi, 2002). The first is an internal factor: the increasing number of unemployed young Omanis and the high number of non-Omanies in various fields. This is caused by the mismatch between labour requirements and the outcomes of the education system (Al-Hammami, 1999). The second reason is an external factor which calls for the reformation of education world-wide due to technological advancement, the need to prepare for the 21st century and the global economy. This reform tries to develop the human resource and upgrade the skills of the Omani workforce.

Different areas are covered by the reform such as (Al-Belushi & Al-Kitani, 1997):

- Developing the aims of education
- Improving the curriculum
- Upgrading teacher's qualifications
- Changing ways of assessment
- Demolishing the afternoon school system
- Extending the school year and day
- Improving various education practices as a result of the new education goals.

This reform introduced basic education and secondary education (Ministry of Education, 2001b). Basic education is for ten years and consists of two cycles: cycle one from year one to four, and cycle two from year five until year ten. Then the secondary education will be for two years (Al-Qasmi, 1999).

4.6.1 Basic Education

Basic education is defined (Ministry of education, 2001a) as:

"... a unified 10-year education, provided by the government in the Sultanate of Oman for all children of school age. It meets their basic education needs in terms of knowledge and skills, enabling them to continue their education and training according to their interests, aptitudes and dispositions. It also prepares them to face the challenges of present circumstances and future development in the context of comprehensive social development"

As a result of this reform, a new programme for teacher training was introduced in the college of education to qualify teachers for the basic education sector. Furthermore, the Ministry of Education conducted in service training courses in order to train teachers for this reform.

4.7 SCIENCE EDUCATION IN SCHOOL

Science education in general education is started from primary one until the end of the secondary schools. Even those who choose the arts stream after they finished their first year in secondary school have to study a general science course. Science is taught as an integrated science from primary one until the final year in preparatory school. In secondary schools science is taught as a separate disciplines: biology, chemistry and physics (Al-Shuaili, 2000). Arts stream students still study science but as a general science course (Al-Busaidi, 1988).

4.8 INITIAL TEACHER TRAINING IN OMAN

In 1970 when the government started to spread education schools all over the country, there was a great demand for teachers. To meet this urgent need, the Ministry of Education recruited some Omani nationals (about 151 Omani teachers) who held the preparatory or secondary school certificates and had basic knowledge about teaching (Al-Rabiey, 2002; Al-Salmi, 2001). However, some had studied only in the Quaranic schools (Kuttab) (Al-Naibi, 2002). To help them to do their job, the Ministry of Education designed short courses to upgrade and train those teachers to be qualified for the profession. From that, it can be concluded that the in-service teacher training started in Oman in early 1972 (Al-Essan, 1995).

Pre-service training has experienced many changes and developments. It started in 1976-1977, when the Ministry of Education opened teachers' training institutes, which offered a 3-years teacher preparation programme for preparatory (grade 9) school-leavers (Al-Busaidi & Bashir, 1997). In 1979-1980, a one-year training system was established for secondary schools leavers. Later in 1984-1985, the intermediate teacher training colleges were developed. These colleges offered a two-year training program. This programme was designed to prepare primary school teachers. By 1990, there were nine intermediate colleges distributed all over the country (Ministry of Higher Education, 2001).

In 1994 the supervision and control of these colleges were shifted from the Ministry of Education to the Ministry of Higher Education. At the same time these colleges were upgraded to be four year university colleges. At the present time, there are six education colleges.

The College of Education at Sultan Qaboos University (SQU) has played a vital role in secondary and preparatory teacher training since 1986. Before the upgrading exercise, the college of education at SQU was the only college in the Sultanate of Oman which trained secondary and preparatory teachers. However, the number of teachers graduating was not sufficient to fill teaching posts in the preparatory and secondary levels.

4.9 COLLEGES OF EDUCATION

There are six education colleges distributed around the country: two for females in Rustaq and Ibri, one for males in Nizwa, three are co-educational colleges, in Sohar, Sur and Salalah (Ministry of Higher Education, 1998-1999). These colleges offered a BEd degree by means of a four year course and a Diploma of Education (one-year course for holders of BA and BSc in subjects other than education who wish to enter teaching).

There are two BEd programmes offered by these colleges: Basic education cycle one programme, which trains students to teach in first cycle basic schools in the reformed education system (see figure 4.1) and preparatory/secondary education programme which trains students to teach for preparatory and secondary schools (Ministry of Higher Education, 2001-2002)(see figure 4.1). In the basic education cycle one programme students can specialize in one of two major domains: science domain and arts domain. In Preparatory/Secondary programme, twelve specializations are offered as Major/Minor specialisations (Ministry of higher Education, 2001)(see table 4.1):

Table 4.1 Specialisations in Preparatory /Secondary program

1. Islamic Studies	2. Arabic Studies
3. Geography/ History	4. History/ Geography
5. Physics/Chemistry	6. Chemistry/Physics
7. Physics/Math	8. Physics/Computer
9. Chemistry/Biology	10. Biology/Chemistry
11. Math/Physics	12. Math/Computer

This study concentrates on those specializations related to science in the preparatory/secondary programme and on the science domain in the first cycle programme. The second part of this study concentrates on the science domain student teachers in the basic education (cycle one).

4.9.1 Aims of the College of Education

There are seven aims for the college of education stated on the main document of these colleges (Ministry of Higher Education,1996):

- Ensuring cohesion and consistence of a university level of teacher education for the various levels of basic and secondary schooling, with the aim of upgrading the quality of primary school teachers.
- Expediting Omanisation of teaching posts at the various levels of education, particularly at the secondary level.
- Enhancing student teacher's competencies in teaching at the various levels and their active participation in co-curricular activities as well as encouraging an effective role in the development of the local community.
- Promoting and upgrading the level of teaching scientific subjects (sciences, mathematics and technology) at the levels of general education in line with the

Ministry's policy of improving the quality of education and copying with the scientific and technological progress of the time.

- Investing college material and human resources in the professional in-service upgrading of the educational sector staff: teachers, supervisors administrators and educational leaders, through the organisation of training courses and workshops.
- Conducting and disseminating educational research to enrich the teaching/learning process.
- Planning and implementing community development services projects.

4.9.2 Structure of the Colleges of Education programmes

Both programmes in the colleges of education are 4 year (8 semester) programmes (Ministry of Higher Education, undated). Each of these programs has 132 credit hours divided into three main components (Al-Busaidi & Bashir, 1997): subject specialization, professional and cultural courses and practicum. The subject specialization component consists of 73 credit hours (55%) and it covers all courses related to the subject that the students' teachers are going to teach. The professional and cultural component consists of 33 credit hours, which made up 25% of the total credit hours (Ministry of Higher Education, 2002-2003). This component covers courses related to education and Arabic language and Islamic and Omani culture. The practicum is the third component and it consists of 26 credit hours, which made up 20% of the total credit hours of the program. Practicum is made up of three main sup-components, which are (Al-Hinai & Al-Jadidi, 1997):

A. The college based practicum: conducted in colleges and consists of Microteaching and Workshops.
B. The serial practicum, which covers administrative internship and fields training for teaching. Serial practicum differs from one semester to another and it is usually for one day per week for certain weeks during each semester starting from second year.
C. The block practicum, starting in the second semester in the second year aims to provide student teachers with a comprehensive teaching experience. In the

block practicum students teachers teach for whole week or more than a week (varies from semester to semeter).

The practicum plays a key role in enhancing the teacher's training. At present Ministry of Higher Education is studying the possibility of re-planning the Practicum according to the cumulative feedback gained from the colleges.

4.10 CONCLUSIONS

It is very clear that huge developments have taken place over a very short time space and that further developments are underway. A number of features are evident. The important role for science and technology in the curriculum are very evident and it is interesting that the emphasis on these subjects seems much greater than in many western countries. The need for large numbers of well trained teachers as well as continuing professional development are also evident.

It is against such contexts that a study of intellectual development, following a model like that developed by Perry, is particularly relevant. The need is for graduate teachers who are well developed in their perception of the nature of knowledge and their understanding of the roles of student and teacher alike. It is also essential in a world where educational systems tend to be driven by assessment, that the approach to assessment reflects the highest levels of Perry development. The next chapter describes the survey of intellectual development which was conducted to establish the perceptions of secondary school pupils and teachers in training. This establishes the base-line measurements for this study.

CHAPTER FIVE

CHAPTER FIVE

METHODOLOGY 1: BASELINE MESUREMENT

5.1 INTRODUCTION

The initial aim of this study was to find out how the perceptions of learning for science education students change over their study years in education colleges in the Sultanate of Oman. Do the study experiences of students in these colleges improve their perceptions of learning? At this stage, however, it was decided to keep an open mind and not make any assumptions. To achieve this, the Perry scheme for intellectual development was adopted. It offers a suitable language to assess students' perceptions of learning.

After reviewing the situation of these colleges and studying the literature and measurement instruments available about Perry scheme, a decision was made to apply a survey based on a questionnaire to measure students' perceptions of learning. One of these questionnaires was applied in secondary schools while the other one was applied in education colleges. Secondary schools were included in order to explore the development of perceptions of learning in the years immediately preceding colleges or universities.

5.2 STUDY QUESTIONS

The primary aim for this study was to investigate the changes in the learning perceptions for the college of education students in the Sultanate of Oman. This part of the study will try to answer the following questions:

1. How do the students' perceptions of the teacher's role change over their study years in the education colleges?
2. How do the students' perceptions of the student's role change over their study years in the education colleges?
3. How do the students' perceptions of the nature of scientific knowledge change over their study years in the education colleges?
4. How do the students' perceptions of assessment change over their study years in the education colleges?

5. Has the student's intellectual development improved as they go from year one in secondary school to final year in Education College?
6. What is the relationship between college students' academic performance and their intellectual development?
7. Is their any significant difference between males and females in term of their perceptions of learning?
8. Is there any significance difference between secondary arts stream and science stream students' in term of their perceptions of learning?

5.3 STUDY SAMPLE

The schools and colleges students sample are now described.

5.3.1 Secondary Schools Sample

Administratively, Oman is divided into several education regions. In all these regions, the curriculum, rules and all core issues are similar. One region was chosen for the study - the Al-Batinah North region (this is the region to which access was most convenient). 1165 secondary students were chosen from four secondary schools within Al-Batinah North education region, two male schools and two female schools. This sample includes students from different years starting from secondary one to secondary three (age 15 to 18) as shown in table 5.1.

Table 5.1 The distribution of the schools' sample according to gender and year

	Year			Total
	1	2	3	
Male	155	265	211	631
Female	102	224	208	534
Total	257	489	419	1165

The secondary schools sample covered students from both streams: science stream and arts stream as shown in table 5.2. Students in secondary schools study all subjects related to both streams and then they start to choose their stream after they finish their first secondary year.

Table 5.2 The distribution of the schools' sample according to stream and gender

	Year		
	1	2	3
Science		269	234
Arts		220	185
Total	257	489	419

5.3.2 Colleges Sample

It was important to try to choose a representative sample. To achieve this, a cross section sample (from all study years in education colleges) of 889 was chosen from the six colleges in the Oman as shown in table 5.3. This sample covered males and females in all study years in these colleges as it is shown in table 5.4.

Table 5.3 The distribution of the colleges' sample according to the colleges

Colleges	A	B	C	D	F	G
Students	164	183	199	78	119	146

Table 5.4 The distribution of the colleges' sample according to year an gender

	Year				Total
	1	2	3	4	
Male	86	124	84	155	449
Female	129	108	135	68	440
Total	215	232	219	223	889

As was stated in chapter four, there are two programmes for science teachers in these colleges: preparatory/secondary science teachers programme and science domain teachers programme. Both these programmes are represented within this sample as shown in table 5.5.

Table 5.5 The distribution of colleges' sample according to year and programme

	Year				Total
	1	**2**	**3**	**4**	
Secondary programme	86	124	135	223	568
Science domain programme	129	108	84	0	321
Total	215	232	219	223	889

5.4 STUDY INSTRUMENTS

It was decided to use two questionnaires to collect data for this study. A questionnaire was chosen as the instrument for this study because it is one of the most appropriate and useful data-gathering instruments in research (Best, 1981). Furthermore, a questionnaire is one of the most useful instruments to study opinions and attitudes (Gay & Airasian, 2000; Fraenkel & Wallen, 2000) and very efficient in terms of researcher time and effort (Robson, 1994; Gay, 1981). By using a questionnaire, researchers can obtain data for thousands of participants in a short time. With all these advantages of using questionnaires in mind, it is important to notice that careful construction and administration of the questionnaire is essential to get the full benefit of these advantages. This was the major priority for the researcher before conducting the survey. In the following section, the construction of the questionnaires will be discussed.

5.4.1 Construction of Instruments

A questionnaire was developed for this study and it was designed in a scientific context. Then this questionnaire was made into two versions (see appendix A, B) in order to be understandable by the two targeted samples. One of them was designed for students in the education colleges, while the other one was designed for pupils in secondary schools. In the schools' version, 'pupils' were used instead of 'students', 'teacher' instead of 'lecturer' and 'lesson' instead of 'lecture'. The following procedures were followed to construct this questionnaire:

1. In his original research Perry gained his data using interviews. Various questionnaire approaches followed but the method used here follows the works of Mackenzie (1999) and Selepeng (2000).
2. Mackenzie used an approach derived from Likert (1932) to measure attitudes measurement without the use of scaling. Selepeng (2000) used the approach developed by Osgood (1952), again without using scaling. In this study both these approaches were used.
3. In the questionnaire, the first ten questions followed the Osgood approach with eight following the Likert approach (see appendix A & B).
4. The questionnaire was looked at carefully by number of researchers experienced in this kind of measurement. After minor modifications the

questionnaire was pre-tried with ten postgraduate students. The aim was to detect possible ambiguities and sources of confusion. After further minor modifications the questionnaire was translated into Arabic and the clarity of the Arabic was checked by native Arabic speakers

5. In Oman the two questionnaires were piloted before applying them in the main survey. Both piloting studies showed that both questionnaires in their Arabic forms (see appendix C & D) were clear and they are ready for the main study survey.

5.4.2 Validation and Reliability of The Instruments

The validity of the two versions of questionnaires used in this study was checked in several ways. Face validity was adopted, by giving these questionnaires to two people familiar with the Perry scheme to validate them. After they studied carefully the questionnaires they suggested slight changes and then approved them. These questionnaires were given to students in the Centre For Science Education (University of Glasgow) to answer and then to comment on. This showed that the questionnaire was clear and the students had no adverse comments. Furthermore, these questionnaires were piloted with two groups in Oman before they were applied in the main survey. The schools questionnaire was distributed to 37 students. While these students were in the process of answering the questionnaire, the researcher observed them and concluded that there were no problems faced by the students in responding questionnaire items. After they returned their questionnaires, some students were interviewed to check if they understood the questionnaire in the same way it designed for. The same thing was done with a group of 21 students in one of the education colleges with college's questionnaire. The interviews indicated that both questionnaires were clear and valid to be applied in the main survey.

Most statistical tests about reliability (other than test and re-test) merely indicate internal consistency. Internal consistency is not relevant to the questionnaire in that most of the 18 questions were testing 18 different things. This type of questionnaire has been used extensively in the past (Mackenzie, 1999; Selepeng, 2000; Moey, 1994) and, with 18 questions and clear instructions, reliability was not thought to be issue.

5.5 METHODS OF COLLECTING DATA

Data was collected from all six colleges in Oman and from four secondary schools in north Al-Batinah education region. Data was collected in the second semester of the academic year 2000/2001. The procedures concerning the data collection in the secondary schools and education colleges are now outlined.

5.5.1 Data Collection In Secondary Schools

Several procedures were followed to collect data from secondary schools, which were:

- A letter was obtained from the Centre For Science Education (University of Glasgow) (see appendix E).
- Permission letters were obtained from Ministry Of Education (see appendix F).
- The data were collected from four secondary schools: two male's schools and two female's schools. This was done by the researcher in most cases or by his colleague. In both cases an instruction sheet was followed in order to maintain constant treatment for all students regardless who distributed the questionnaire (see appendix G).

5.5.2 Data Collection In Education Colleges

In education colleges, several procedures were followed to collect data from students in the education colleges in the Sultanate of Oman, which were:

- A letter was obtained from the Centre For Science Education (University of Glasgow) (see appendix E).
- A permission letter was obtained from the Directorate General of Colleges (Ministry of Higher Education – Sultanate of Oman) (see appendix H).
- The data was collected from education colleges by following an instruction sheet as described above (see appendix G).

5.6 STATISTICAL TREATMENT OF THE DATA

Some statistical tests were used in order to make objective judgments from the questionnaires. The SPSS package was used to analyse the data obtained from the survey. Kinnear &Gray (2000) book was used to guide the correct use of the SPSS software.

Data from the questionnaires were analysed using SPSS. Each question was treated separately and chi-square was used where appropriate. Johnstone (1998) distributed students into three positions A, B and C in his adaptation of Perry Scheme (see chapter two). The questionnaires, which were developed for this study, aimed to find out students' positions. In the following few paragraphs the method of locating students positions from their responses to the questionnaires will be shown.

In the first part of the questionnaire, there are ten 'Osgood' questions. In order to understand how to decide students' positions in these questions, two examples will be discussed. The first example is question three.

	Statement							*Statement*
3	I believe it is the job of the lecturer to supply me with all the knowledge I need							The duty of the lecturer is not to teach me everything, but to help me to think for myself.

In this example, the C statement is at the right side of the questionnaires and the A statement is on the left side. In this case the first two boxes from the right represent C position whereas the first two boxes from left represent A position. The other two boxes in the middle represent B position. So, if a student chooses the third box from the right, that means he is in B position.

The other example is question seven.

	Statement						*Statement*
7	I do not believe that all scientific knowledge represents the 'absolute truth'.						We cannot call anything scientific knowledge if it is not absolutely true.

In this example, C position statement is on the left side and A statement is on the right. In this case the first two boxes from the left represent C position, whereas the first two boxes from the right represent A position. The other two boxes in the middle represent B position. The boxes were grouped into three positions because of the three positions in the Johnstone adaptation of Perry scheme. The questionnaire will be frustrating if it was designed with only three boxes and if there were more than six boxes they may overload the working memory of the students.

Part two from the questionnaires consists of eight questions using Likert type five points scale. In order to understand how to decide students' positions depending on their responses to these questions, two examples will be discussed. Statements used in this part will either be C statements or A statements. One example will be about an A statement and the other one about a C statement. For example, question five in part two.

	Statement	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
5	It is a waste of time to work on problems which have no possibility of producing a clear-cut, unambiguous answer					

The statement in this question is an A statement, so *"strongly agree"* and *"agree"* represent position A while, *"disagree"* and *"strongly disagree"* represent position C. *"Uncertain"* represents the B position. Keeping all that in mind, if a student chooses disagree that means he is in a C position with regard to this question. The other example is question eight in part two where the statement is a C statement.

	Statement	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
8	I like exams which give me an opportunity to show I have ideas of my own					

In this question, *'strongly agree'* and *'agree'* represent a C position whereas *'disagree'* and *'strongly disagree'* represents an A position. Uncertain represents a B position. So if a student choose strongly disagree we can considered his in an A position.

After the position of each student is decided, the percentages of students in all three positions will be represented for each question. The actual distribution of the responses (either to five or six categories) will be used if chi-square (χ^2) or Kendall's tau-b correlation is used and all analyses will use raw data, not percentages.

Year groups can be compared. For this purpose Chi-square (χ^2) was used, as a 'goodness of fit' test. When male and female responses were compared, Chi-square (χ^2) was also used, although this time as a contingency test (see appendix I for details of χ^2).

When students' responses in the questionnaire were compared to academic performance, correlation was employed. Because of the categorical nature of the data, Kendall's tau-b correlation was used. The same test was employed when the students responses in the questionnaire were compared to number of years spent in studying science (see appendix J for details of Kendall's tau-b correlation).

Significance levels are quoted as probabilities with .05 being taken as the significance level. In the analysis, the following will be used:

* *will be put near p-value when the chi-square is significant at the 5% level of probability ($p \leq .05$).*

** *will be put near p-value when the chi-square is significant at 1% level of probability ($p \leq .01$).*

The following chapter presents the data gathered and discusses its interpretation. The data are shown in full in appendix K.

CHAPTER SIX

CHAPTER SIX
DATA ANALYSIS (BASELINE MEASUREMENT)

6.1 INTRODUCTION

In this chapter, the data from the questionnaires will be summarised and discussed. Four broad areas have been identified:

(a) perceptions of lecturer's role.
(b) perceptions of student's role.
(c) perceptions of the nature of scientific knowledge.
(d) perceptions of assessment.

Each area will be considered in turn and the questions which relate to that area will be discussed individually before drawing some more general conclusions.

For each question, a table will show the percentages of students who are in each of positions A to C under the adapted Perry scheme. This data will also be summarized in graphical form. A second graph will show the C/A ratio as it changes over the seven year groups. Responses to the question from successive year groups will be compared using chi-square to see where there are significance changes.

In the graphs used, the points are linked by lines. These lines have no significance and are used merely for clarity. In the discussion, the phrases 'perceptions of learning' and 'intellectual development' will be used interchangeably since, in the Johnstone adaptation of the Perry scheme, students intellectual development is measured through their perceptions of learning. Thus, when it is stated that students are more intellectually developed, this means that they have a positive learning perception and the percentage of students indicating a C position is high.

It has to be noted that the population in each year group is not the same. At school level, year 1 students study all subjects in the arts and science streams. In year 2 and 3, only science students are involved. Not all school pupils will elect to attend college and, therefore, the four college years are not necessarily equivalent to the school years. Comparisons, therefore, are made with some caution.

6.2 STUDENTS' PERCEPTIONS OF LECTURER'S ROLE

This section will try to answer the following questions:

How do the students' perceptions of lecturer's role change over their study years in the education colleges?

To answer this question, the percentages of students at different positions in all seven years starting from the first year in secondary schools to the final year in education colleges for all questions related to students' view of teacher's role will be presented. Then Chi-square (χ^2) will be used to compare between consecutive years. The C/A ratio will be used also in order to describe students' perceptions of lecturer's role and to find out the changes on their perceptions over years.

Part A. Q 3. I believe it is the job of the lecturer to supply me with all the knowledge I need \ The duty of the lecturer is not to teach me everything, but to help me to think for myself

Table 6.1: the percentages of students according to their positions and study years for question 3 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	55.4	55.8	46.5	23.8	18.6	15.4	20.9
	B	11.6	15	13.9	15.8	13.3	14	18.1
	C	32.9	29.2	39.6	60.4	68.1	70.6	61
C/A Ratio		0.59	0.52	0.85	2.54	3.66	4.58	2.91

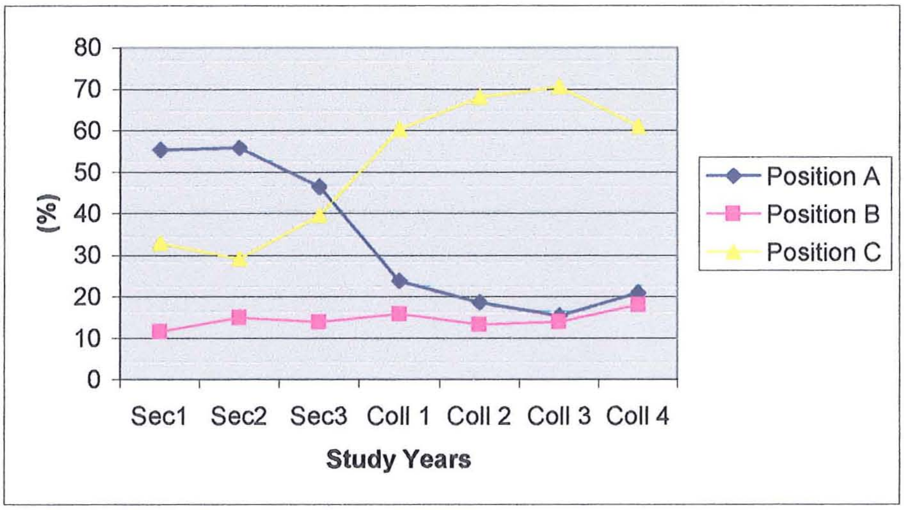


Figure 6.1: the percentages of students according to their positions and study years for question 3 part A

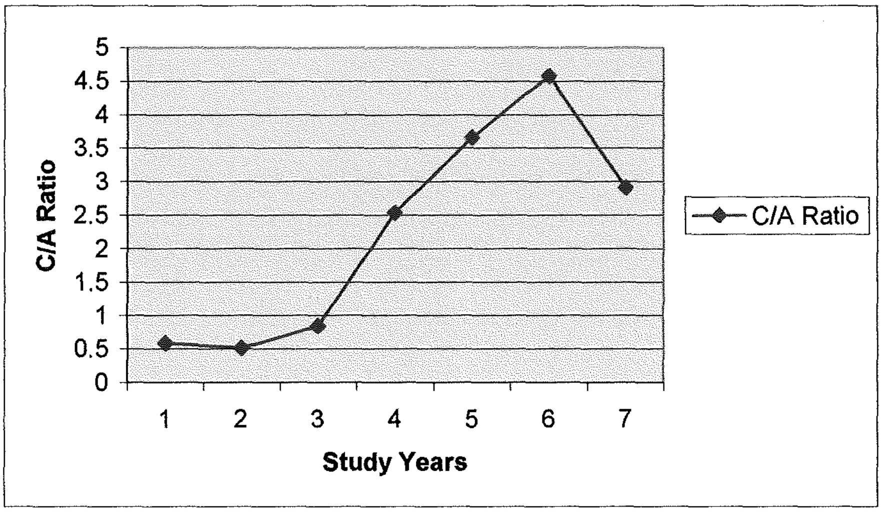


Figure 6.2: the C\A ratio of students according to their study years for question 3 part A

Table 6.2: chi-square between different years for question 3 part A

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	7.8	14.4	40.6	8.0	5.4	8.4
d.f	5	5	5	5	5	5
P. value	.17	.01**	.00**	.15	.37	.14
Intellectual development	no	increase	increase	no	no	no

A great difference has appeared between the school students and college students with regard to their perception of lecturer's roles (table 6.1 and figures 6.1 and 6.2). It is noticed that the percentage of students in C position varies between 29.2 % to 39.6% in secondary schools while, in education colleges, it rise to between 60.4% to 70.6%. This reflects the higher intellectual development among college students in terms of their view of teacher roles. Furthermore, from figure 6.2, the C/A ratio supports that. Table 6.2 shows that there are two significance improvements between years two and three in secondary schools (p = .01)and between year three in secondary school and year one in education college (p = .00). However, there is a rapid increase in the percentage of students in C position and in the C/A ratio after year 3 in secondary school until the third year in the education colleges followed by a decrease in the final year in the college. Table 6.1 shows also that the highest percentage of students in B position is in the final year in the education colleges. This may be related to the students' uncertainty about the next stage of their life after they finish the college. The significant change between year three in the secondary school and first year in the college may be related to two factors: the difference between two populations or to the experience students gain in the education colleges.

Part A. Q4. I think lecturers should avoid teaching materials that they know students will find difficult \ lecturers should aim to provide challenges to their students by introducing difficult topics.

Table 6.3: the percentages of students according to their positions and study years for question 4 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	34.9	20.4	21	24.1	23.2	18.9	20.6
	B	20.4	20.1	19.3	32.5	31.6	30.9	28.4
	C	44.7	59.5	59.7	43.4	45.2	50.2	50.9
C/A Ratio		1.28	2.92	2.84	1.80	1.95	2.66	2.47

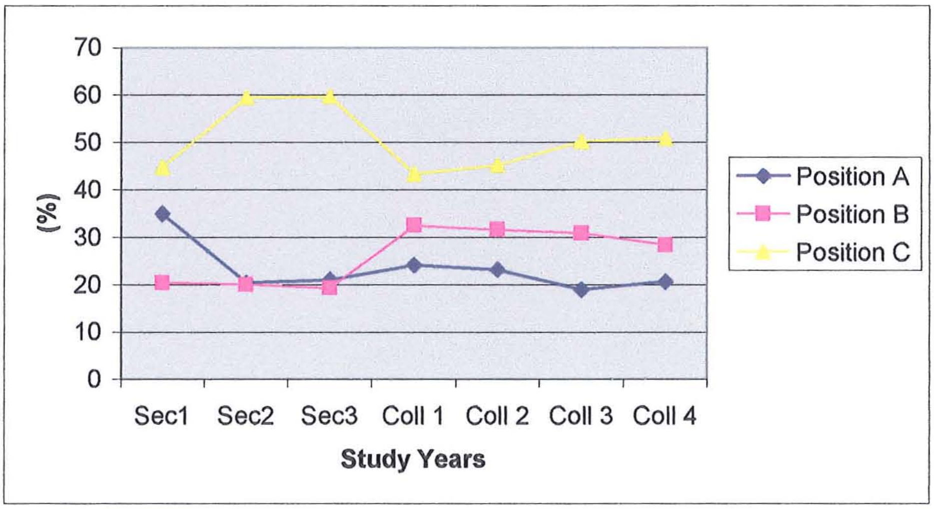


Figure 6.3: the percentages of students according to their positions and study years for question 4 part A

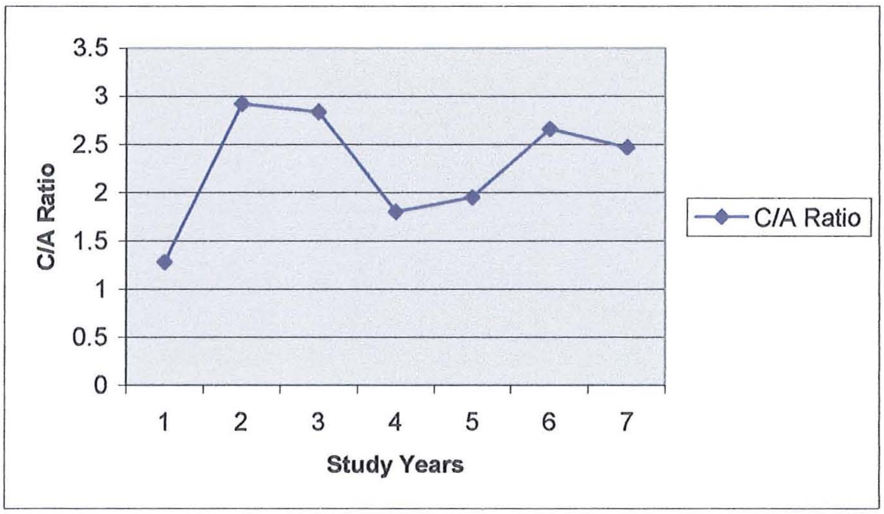


Figure 6.4: the C/A ratio for students according to their study years for question 4 part A

Table 6.4: chi-square between different years for question 4 part A

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	3.1	6.2	19.0	4.2	5.7	6.7
d.f	5	5	5	5	5	5
P. value	.68	.29	.00**	.52	.33	.24
Intellectual development	no	no	decrease	no	no	no

From table 6.3 and figures 6.3 and 6.4 we notice that most school and college students are in position C. Furthermore, they show that the percentage of secondary school students in C position are slightly higher than college students. On the other hand from table 6.3 it is clear that the percentages of college students in position B are higher than secondary school students. In general, it can be said that secondary school students are more intellectually developed than college students with regard to this question. This may suggest that most students and pupils (especially secondary schools pupils) accept that at school or college they need to learn new things and that some may not be easy.

With regard to college students, table 6.3 and figure 6.3 show that the percentage of students in C position increases over their study years and the percentage of students in A position decreases with only one exception in the final year of their study where the percentage of students in A position increases. Figure 6.4 shows that C/A ratio for college students increases from year one to year 3 then decreases in year four. However, table 6.4 shows that the only significant change is between third year in secondary school and first year in education college (p = .00). However, this change should be related to the change of the population since not all secondary pupils go to education colleges. It could be also related to the experiences gain in the education colleges.

Part B Q 3. There is not any point in class teaching which includes things which will not be in the exam

Table 6.5: the percentages of students according to their positions and study years for question 3 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	35.3	45.2	43.7	33.5	23.6	26.6	26.3
	B	15.5	13.8	16.6	15.6	14.0	11	7.8
	C	49.2	41	39.7	50.9	62.4	62.4	65.9
C/A Ratio		1.39	0.91	0.91	1.52	2.64	2.35	2.51

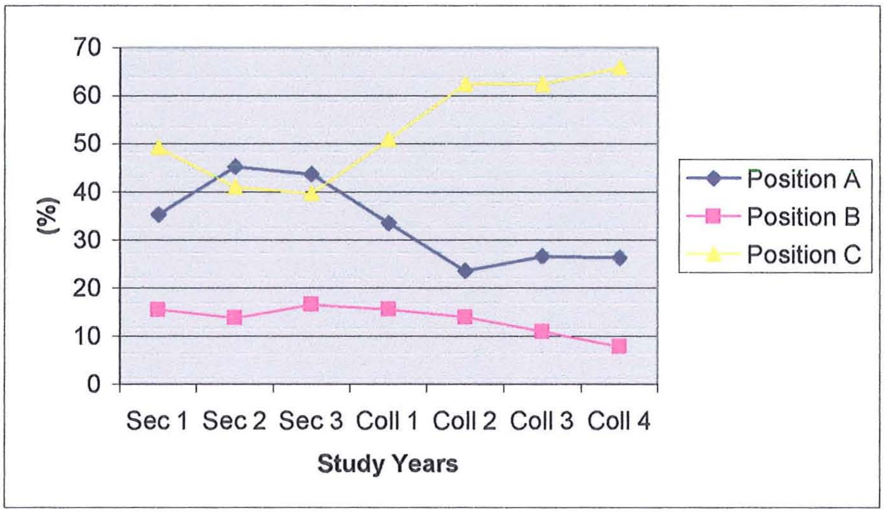


Figure 6.5: the percentages of students according to their positions and study years for question 3 part B

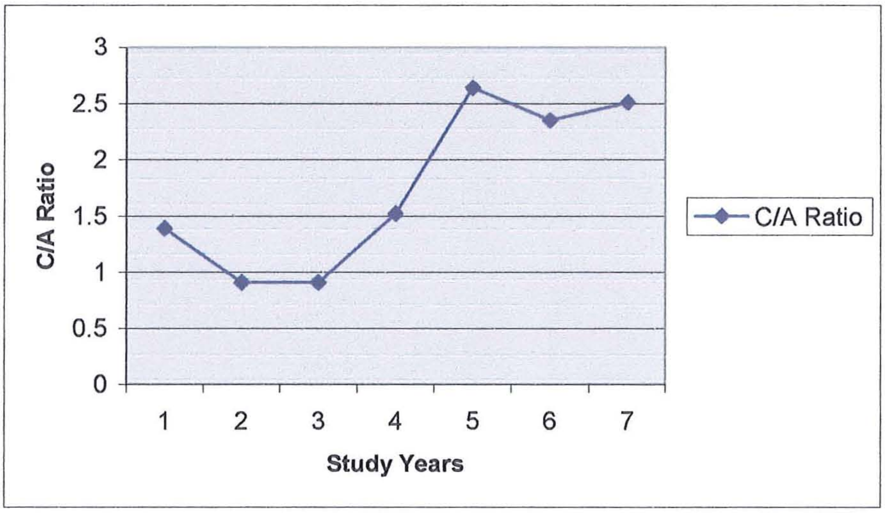


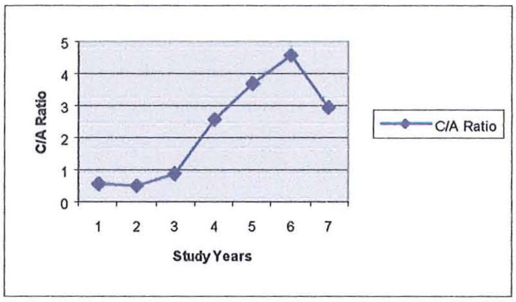
Figure 6.6: the C/A Ratio for students according to their study years for question 3 part B

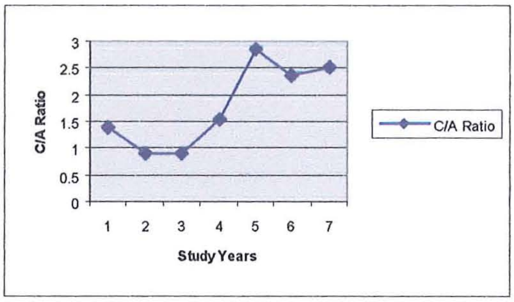
Table 6.6: chi-square between different years for question 3 part B

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	4.4	2.8	9.1	7.7	2.3	3.0
d.f	4	4	4	4	4	4
P. value	.36	.58	.06	.10	.67	.55
Intellectual development	no	no	no	no	no	no

Table 6.5 and figures 6.5 and 6.6 show that most colleges' students are in C positions while the majority of second and third secondary schools' students are in A position. On the other hand, the percentages of colleges' students in A position are lower than secondary schools' students. Furthermore, figure 6.6 shows that the ratio of C/A decreases in second year in secondary schools then stays the same in third year and starts to increase in first and second years of education colleges. A slight decrease occurs in third year and an increase in the fourth year. Generally there is a continuous decrease in students' intellectual development with regard to this question over their studying years in secondary schools followed by an increase during their studying years in education colleges and a decrease in third year. However, chi-square results in table 6.6 show that there is not any significant difference between different years in secondary schools and education colleges with regard to their perceptions of the lecturer's role.

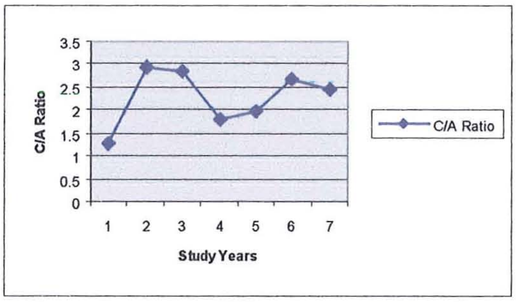
Summary





Question 3 part A

Question 3 part B



Question 4 part A

Figure 6.7: the C/A Ratio for students according to their study years for questions related to students' perceptions about the lecturer's role

It is important to notice that the C/A graphs above (and in future comparisons) have different scales on the Y axis. In comparing the graphs, the general shape only should be considered.

As an answer to the question raised before about the changes in students' perceptions of lecturer's role over their study years in education colleges as (figure 6.7), it can be said that students' perceptions improve in general. This is because in two out of three questions, the percentages of students in C position are higher than secondary schools. Moreover, there is a continuous improvement in students' perception of lecturer's role over their study years in education colleges and a slight regression in the final year.

It is clear from students' responses to question three part A that there are opposite perceptions between school students and college students. Most school students think that the teacher's role is to supply them with all knowledge they need (position A), while as most college students think that the lecturer's role goes beyond that to teach students how to think.

This is probably because students in secondary science tend to be passive learners and the assessment mainly concentrates on assessing the cognitive domain and most teachers just concentrate on what has been written in the science text books. On the other hand, education college students are put into the situation of teachers in practicum (teaching training in schools). Through this situation students start to realise that in order to teach science in the proper way the teacher's role should go beyond teaching knowledge, to the more important process of developing scientific thinking. Furthermore, the educational and psychological courses in the education colleges may help students to understand the students' nature and their educational needs. The changes here could not be related only to the natural growth. This is because if these changes are only related to the natural growth then there will be continuous growth over years which is not the case in these questions.

6.3 STUDENTS' PERCEPTIONS OF THEIR ROLE

How do the students' perceptions of student's role change over their study years in the education colleges?

Part A. Q 1. In order to pass my courses, I need to study just what the lecturer tells me \ I do not have to rely totally on the lecturer. Part of my learning is to work things out myself

Table 6.7: the percentages of students according to their positions and study years for question 1 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	32.3	29.4	16.7	19	23.1	16.7	23.7
	B	12.8	14.5	16.2	17.1	14.3	18.1	18.7
	C	54.9	56.1	67.1	63.9	62.6	65.2	57.5
C/A Ratio		1.70	1.91	4.02	3.36	2.71	3.90	2.43

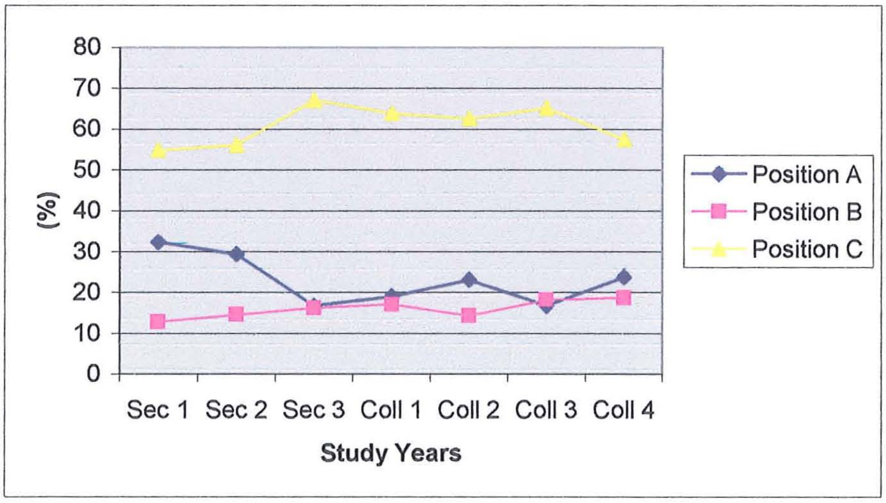


Figure 6.8: the percentages of students according to their positions and study years for question 1 part A

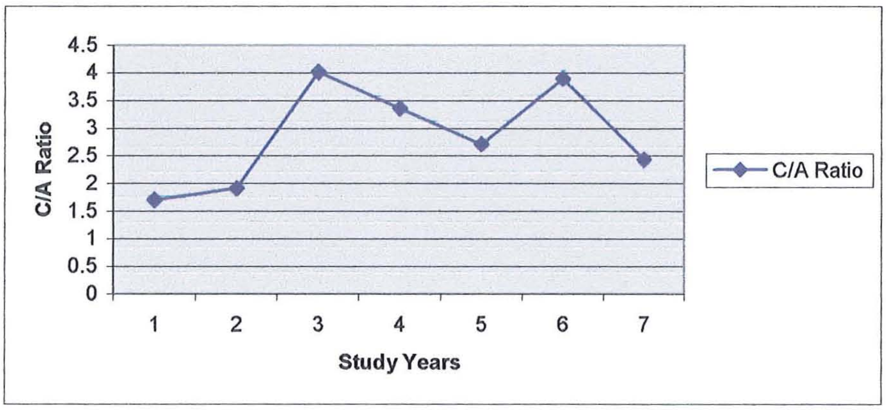


Figure 6.9: the C/A Ratio for students according to their study years for question 1 part A

Table 6.8: chi-square between different years for question 1 part A

	Compression between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	10.5	18.3	1.9	4.4	3.7	4.6
d.f	5	5	5	5	5	5
P. value	.06	.00**	.86	.49	.59	.46
Intellectual development	no	increase	no	no	no	no

The results in table 6.7 show that the percentage of students in a C position starts to rise from first year in secondary school until the third year. On the next years in education colleges we notice that percentage of students in a C position start to decline in year one and two and start to rise in year three and decline again in year four. It is also obvious that even if there is a decline in first, second and fourth year in the college years, the percentage of students in the C position is still higher than first and second years in the secondary schools. However, figure 6.9 shows the C/A ratio in different years supports the results from the first figure. Table 6.8 shows that the only significance change is between year two and three in secondary schools ($p = .00$) where the intellectual development increase rapidly and then stays as it is all following years. The results show also that there is no continuous improvement in colleges students' perceptions about student's role over their study years in the education colleges although in general their perceptions are more developed than secondary schools' students. Figure 6.9 also show that the C/A ratio peaks in two years, which are year three in secondary school, and year three in the college. The peak in secondary school is significant. This may result from the fact that the third secondary year is very important for students. This is because their results in this year will decide to which colleges they can apply and to get a high grade they need to do many things by themselves.

Part A. Q2. I cannot be wrong if I accept what the lecturer says. If I question anything, I might end up failing / I do not believe in just accepting what the lecturer says without question. Success involves thinking for myself

Table 6.9: the percentages of students according to their positions and study years for question 2 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	6.3	12.4	3.4	5.7	3.9	4.2	5.5
	B	17.4	22.6	19.8	16.7	13.9	10.2	15.5
	C	76.3	65	76.7	77.5	82.2	85.6	79
C/A Ratio		12.11	5.24	22.56	13.60	21.07	20.38	14.36

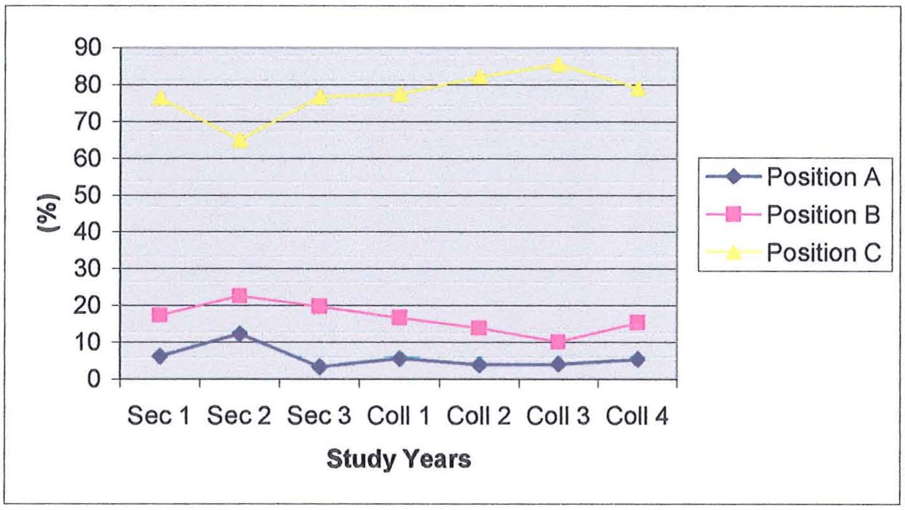


Figure 6.10: the percentages of students according to their positions and study years for question 2 part B

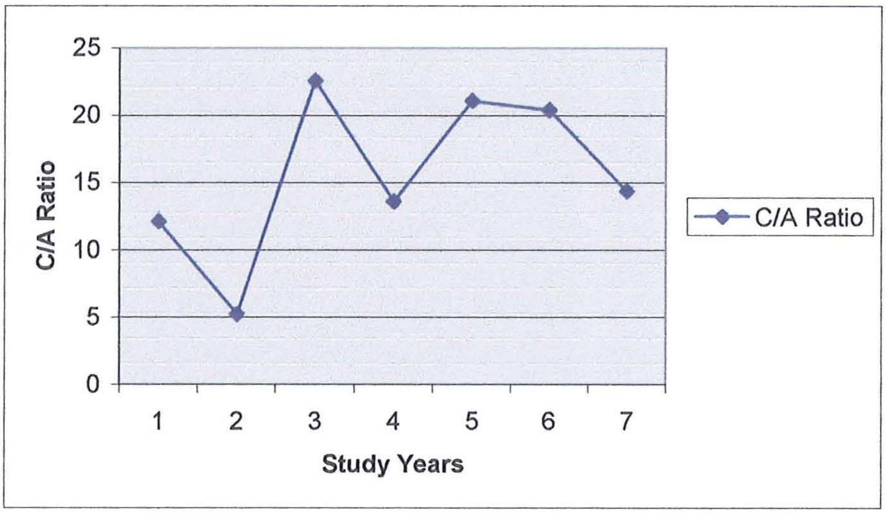


Figure 6.11: the C/A Ratio of students according to their study years for question 2 part A

Table 6.10: chi-square between different years for question 2 part A

	Compression between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	11.4	18.9	5.7	3.0	1.9	4.7
d.f	5	5	5	4	4	4
P. value	.04*	.00**	.34	.56	.75	.32
Intellectual development	decrease	increase	no	no	no	no

The results from table 6.9 and figure 6.10 show that most students in secondary schools and colleges are in position C and they think that their roles as students are more than accepting what has been said by the teacher but to think for themselves. Moreover, the percentages of colleges' students in C position for all study years are higher than schools' students. Figure 6.10 and table 6.11 show that the percentages of those in C position decrease significantly in second year of secondary school ($p = .04$) then it start to increase significantly between year two and three in the secondary school ($p = .00$). In following years in the education colleges even if there is an increase in percentage of students in C position and slightly decrease on fourth year, all these changes are not significant changes. Figure 6.11 shows the same pattern as in figure 6.10. The decrease in the C/A ratio in the final year in the education colleges may be related to the students' fear of their future as teachers. The decline in the C/A ratio in the first year of education colleges is due to students' move from position B to A although the percentage of students at C position is still higher than the previous year as shown in table 6.9. Generally, there is an increase in students' intellectual development over the study years with a decrease in the final year in the education colleges.

Part A. Q 5. It is good to work with other students because, by listening to their points of view, I can correct my ideas \ I prefer not to work with other students because then I stand less chance of picking up wrong ideas

Table 6.11: the percentages of students according to their positions and study years for question 5 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	9.8	10.4	7.1	4.7	2.6	3.2	2.3
	B	12.5	12.3	12.4	12.7	7.4	6.4	11
	C	77.6	77.2	80.5	82.5	90	90.4	86.7
C/A Ratio		7.9	7.42	11.33	17.55	34.61	28.25	37.70

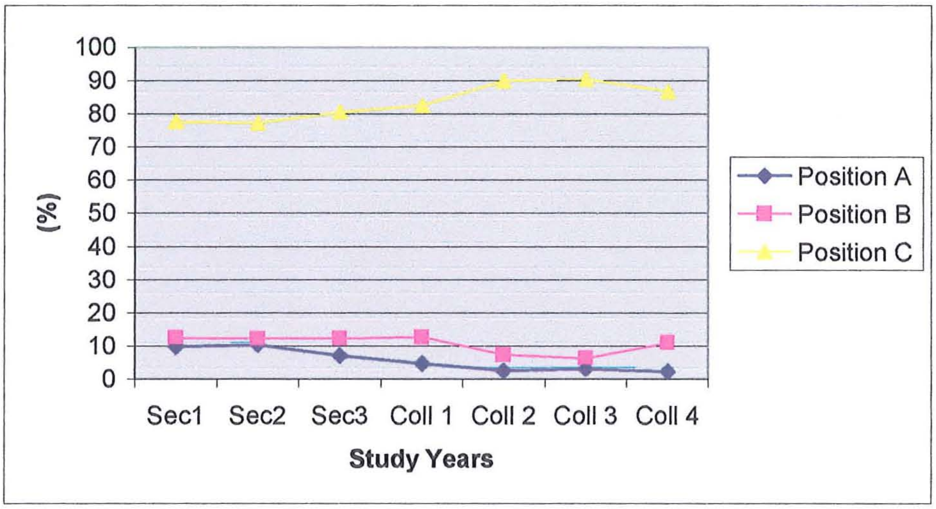


Figure 6.12: the percentages of students according to their positions and study years for question 5 part A

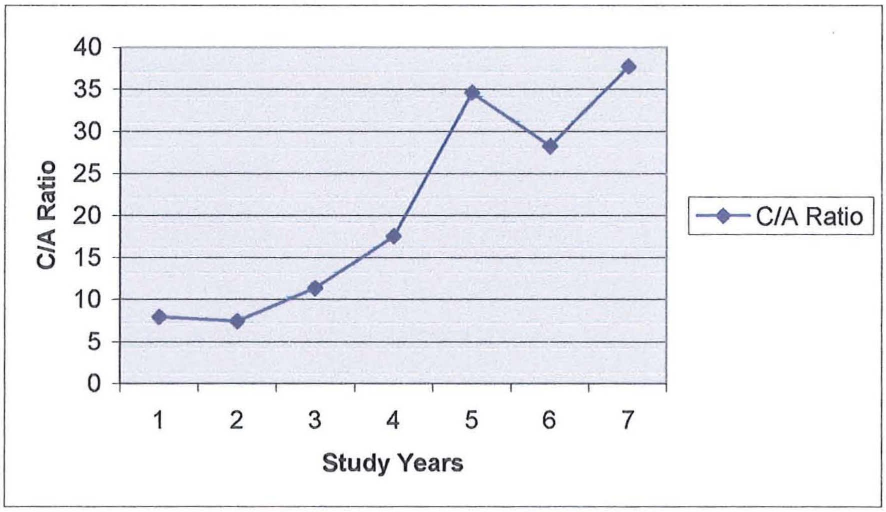


Figure 6.13: the C/A Ratio for students according to their study years for question 5 part A

Table 6.12: chi-square between different years for question 5 part A

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	4.6	5.8	5.1	6.0	1.1	3.4
d.f	5	5	5	3	3	3
P. value	.47	.33	.40	.11	.78	.33
Intellectual development	no	no	no	no	no	no

The results from table 6.11, figures 6.12 and 6.13 show that most students in secondary schools and education colleges are in position C with at least 77.2 % of total responders in C position in second year secondary and up to 90.4 % in third year in education college. In addition the percentages of students in C position in colleges are higher than any year in secondary schools. The results also show that in general there is an improvement in students' intellectual development as the students progress from secondary school to the end of education colleges. However, after a continuous rise in the percentages of students in C position there is a slight decline in the final year in the education colleges. Chi-square results in table 6.12 show that there is no significant change between different years. Although there is no significant change in students' perceptions of the student's role, the intellectual level of the students is high from the beginning which means that further improvement is not likely.

Part B. Q 2. Sometimes I find I learn more about a subject by discussing it with other students than I do by sitting and revising at home

Table 6.13: the percentages of students according to their positions and study years for question 2 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	18.4	14.6	16.9	11.6	13.1	14.6	10
	B	12.1	10.5	11.1	13.9	4.4	9.6	6.4
	C	69.5	74.9	72	74.4	82.5	75.7	83.6
C/A Ratio		3.78	5.13	4.26	6.41	6.30	5.18	8.36

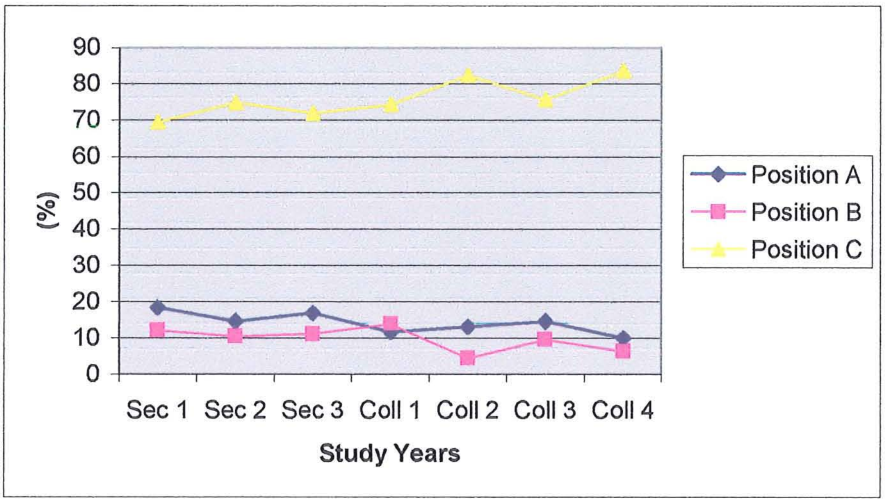


Figure 6.14: the percentages of students according to their positions and study years for question 2 part B

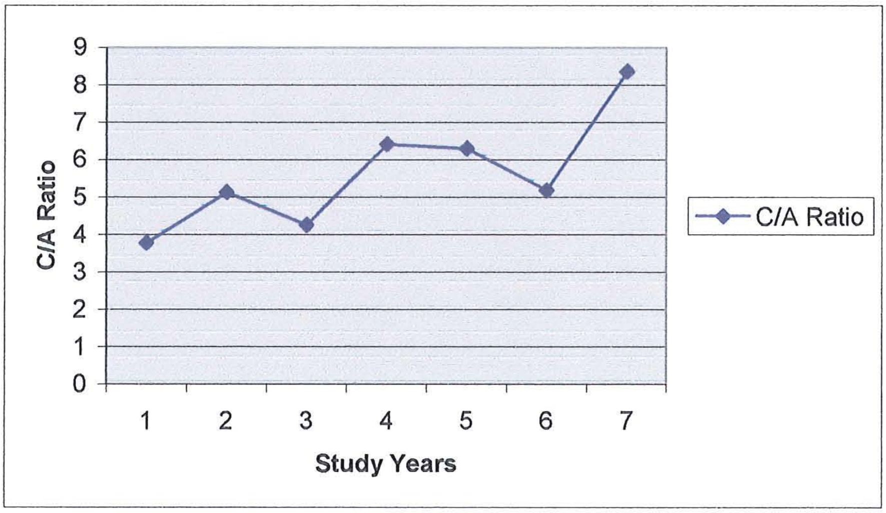


Figure 6.15: the C/A Ratio for students according to their study years for question 2 part B

Table 6.14: chi-square between different years for question 2 part B

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	2.7	.7	4.3	12.5	7.2	3.9
d.f	4	4	4	3	3	3
P. value	.60	.95	.37	.01**	.07	.27
Intellectual development	no	no	no	increase	no	no

With regard to this question, table 6.13 and figures 6.14 and 6.15 show that most students are in position C and in general the percentages of college students in C position are higher than school students. From C/A ratio in table 6.13 and figure 6.14 it is noticed that there is an increase in second year in secondary school followed by a decrease in third year. In education colleges, it is noticed an increase in the first year followed by decrease in second and third years. A sharp increase was noticed in fourth year in education colleges. However, chi-square results in table 6.14 show that there is only a significant change between first and second years in colleges ($p = .01$). This may due to the practicum experience where sometime students need to discuss their teaching with other students and with their supervisors.

Part B. Q6. I feel uncomfortable when I am left to express an opinion, not knowing the view the lecturer feels

Table 6.15: the percentages of students according to their positions and study years for question 6 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	40.9	40.1	43	38.2	30.4	25.5	30.7
	B	23.2	17.2	32.2	17.9	12.9	16.2	17.9
	C	35.8	42.7	24.8	49.9	56.7	58.3	51.4
C/A Ratio		0.87	1.06	0.58	1.31	1.86	2.29	1.67

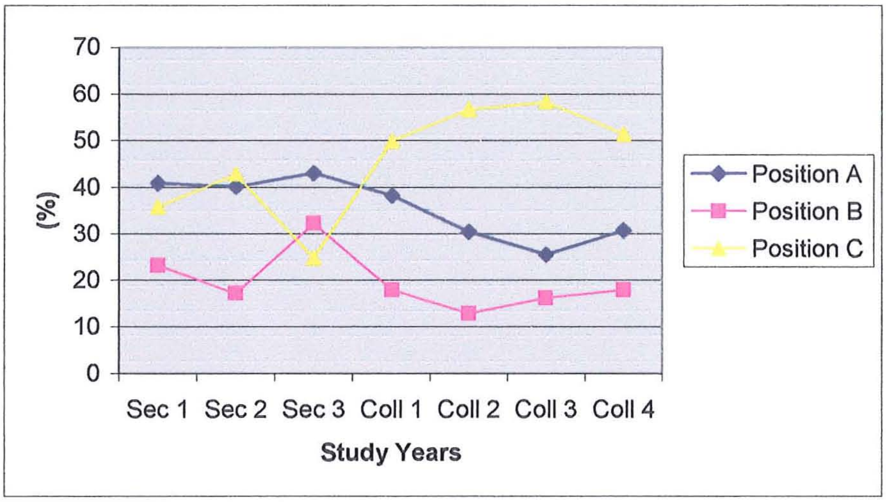


Figure 6.16: the percentages of students according to their positions and study years for question 6 part B

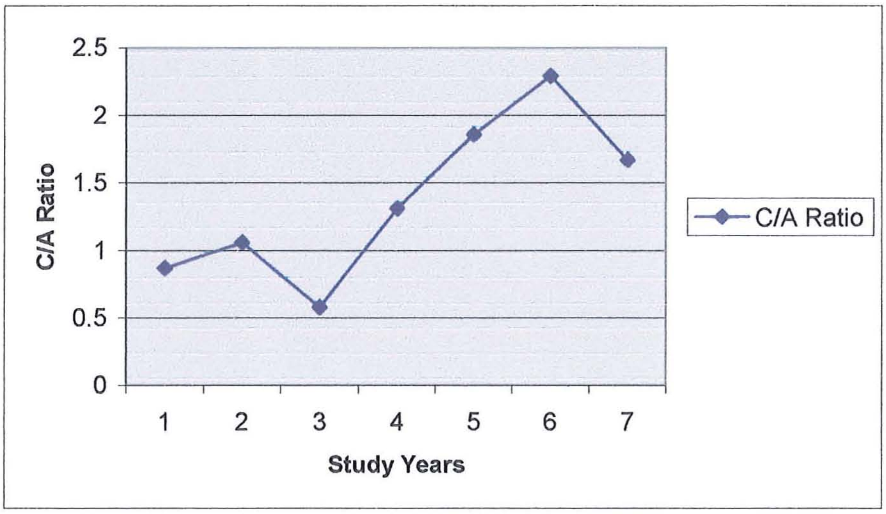


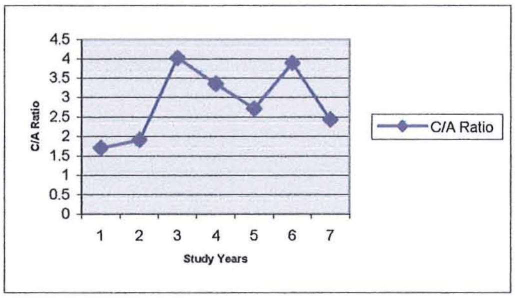
Figure 6.17: the C/A Ratio for students according to their study years for question 6 part B

Table 6.16: chi-square between different years for question 6 part B

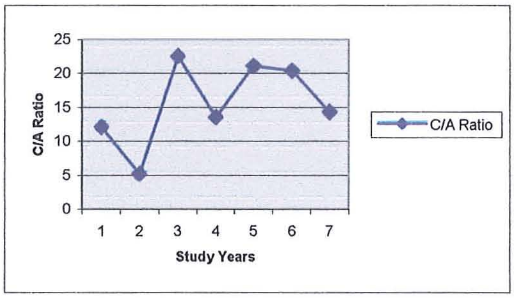
	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	4.6	4.6	2.1	13.5	1.8	3.6
d.f	4	4	4	4	4	4
P. value	.33	.33	.71	.01**	.78	.47
Intellectual development	no	no	no	increase	no	no

From table 6.15 and figures 6.16 and 6.17 it can be noticed that most school students are in position A while most college students are in position C. From figure 6.16, the C/A ratio shows that there is an increase in second years of secondary school followed by a decrease in third year. Furthermore there is an increase in year one, two and three in education colleges followed by a decrease in fourth year. However, chi-square results in table 6.16 show that the only significant change is the increase between year one and two ($p = .01$) in education college. The results show that the majority of students are in position A at secondary year one and this remain dominant throughout secondary school level. This allows the possibility of a substantial increase to a C position at college level. This is seen clearly in the significant increase shown from year one to year two in the education colleges. This attitude change probably reflects the change of learning style at college which shows after a year's experience of college.

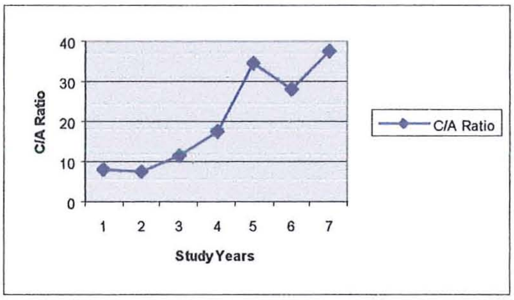
Summary



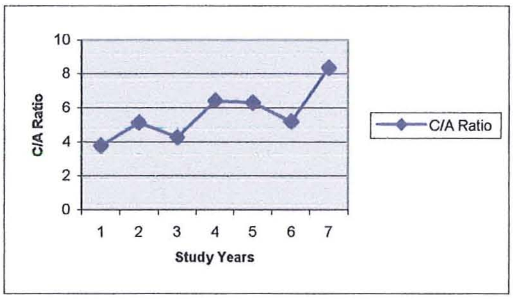
Question 1 part A



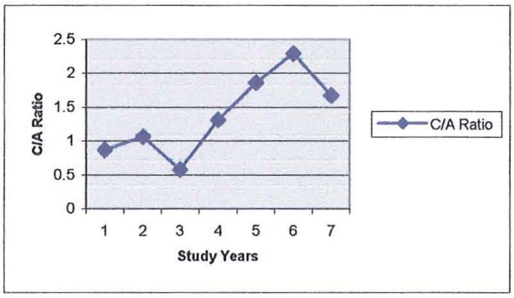
Question 2 part A



Question 5 part A



Question 2 part B



Question 6 part B

Figure 6.18: the C/A Ratio for students according to their study years for questions related to students' perceptions about the student's role

As an answer to the question raised before about changes in the students' perceptions of student's role over their study years in education colleges, several points can be concluded from the previous analyses of the questions related to student's role and from figure 6.18. Firstly, in all questions related to students' perceptions of student's role in learning science, the percentages of colleges' students in C position are, in general, higher than secondary schools students.

Secondly, in most questions the majority of college students and school students are in C position with just one exception (in question 6) (part B) where the majority of secondary schools' students are in A position in general.

Thirdly, there is a decline in the percentages of students in C position in the fourth year in the education colleges in four out of five questions related to the student's role in learning science. Finally, in general there is an improvement in students' perceptions of student's role in learning science over their study years in the education colleges.

The general improvement of students' perceptions of the student's role in learning science in education colleges may be due to their experiences in these colleges. Students in these colleges are placed in teaching situations in practicum. Through this situation students start to realise that, in order to teach science in a proper way, the teacher's role should go beyond teaching knowledge to the important part which is developing the scientific thinking through science. Furthermore, the educational and psychological courses in the education colleges help students to understand the students' nature and their educational needs.

6.4 STUDENTS' PERCEPTIONS OF THE NATURE OF SCIENTIFIC KNOWLEDGE

How do the students' perceptions of the nature of scientific knowledge change over their study years in the education colleges?

Part A. Q6. All one has to do in science is to memorise things \ Understanding science is the key part of science study

Table 6.17: the percentages of students according to their positions and study years for question 6 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	16.7	13.2	6.8	1.4	0.4	0.5	1.4
	B	12.7	11.3	11.1	11.3	10.5	11.5	13.4
	C	70.5	75.5	82.1	87.3	89	88	85.2
C/A Ratio		4.22	5.72	12.07	62.36	222.5	176	60.8

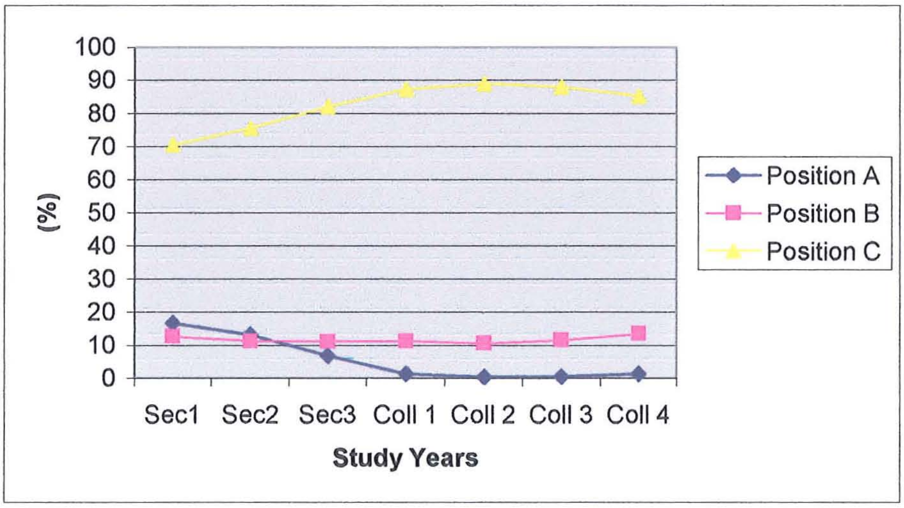


Figure 6.19: the percentages of students according to their positions and study years for question 6 part A

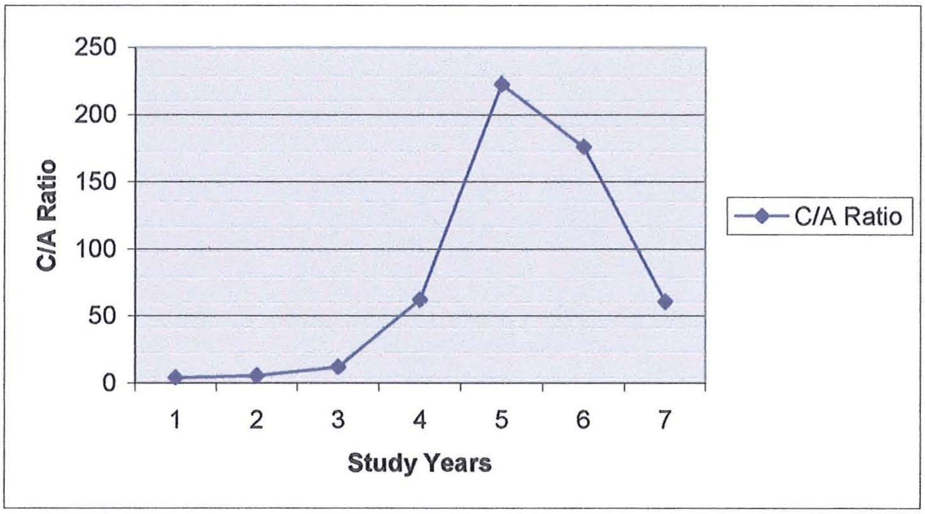


Figure 6.20: the C/A Ratio for students according to their study years for question 6 part A

Table 6.18: chi-square between different years for question 6 part A

	Compression between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	5.4	11.6	9.6	2.5	2.3	6.1
d.f	5	5	3	3	3	3
P. value	.36	.04*	.02*	.48	.52	.11
Intellectual development	no	increase	increase	no	no	no

Table 6.17 and figures 6.19 and 6.20 show a continuous increase in percentages of students in C position from year one in secondary schools to year two in educations colleges followed by decreases in third and fourth years in education colleges. Generally we can say that the percentages of students in C positions in education colleges are higher than and percentage in secondary schools study years. Furthermore, the percentages of colleges' students in A position are very low compared to the percentages of schools' students. However, the chi-square results in table 6.18 show that the only significant change is between years two and three in secondary school ($p = .04$) and year three in secondary school and year one in the education college ($p = .02$) and all other changes are not significant, minor changes in already small numbers in position A causing large changes in C/A ratio. The increase between year two and three in secondary school may be related to the awareness that it is more likely to get good grade when you understand science. For those in the third year in secondary schools (which is the final year and the most important year because their percentages in this year will decide what can they study after they finished secondary schools) it is very important to get a good grade. The increase between third year in the secondary school and first year in the education colleges may relate to the experiences they went through in these colleges.

Part A Q7. I do not believe that all scientific knowledge represents the 'absolute truth' / We cannot call anything scientific knowledge if it is not absolutely true

Table 6.19: the percentages of students according to their positions and study years for question 7 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	48.9	38.4	41.3	45	41	38.1	33.5
	B	27.8	33.1	35.2	31.1	25.5	20	23.6
	C	23.3	28.5	23.5	24.9	33.5	41.9	39.1
C/A Ratio		0.48	0.74	0.60	0.55	0.82	1.10	1.16

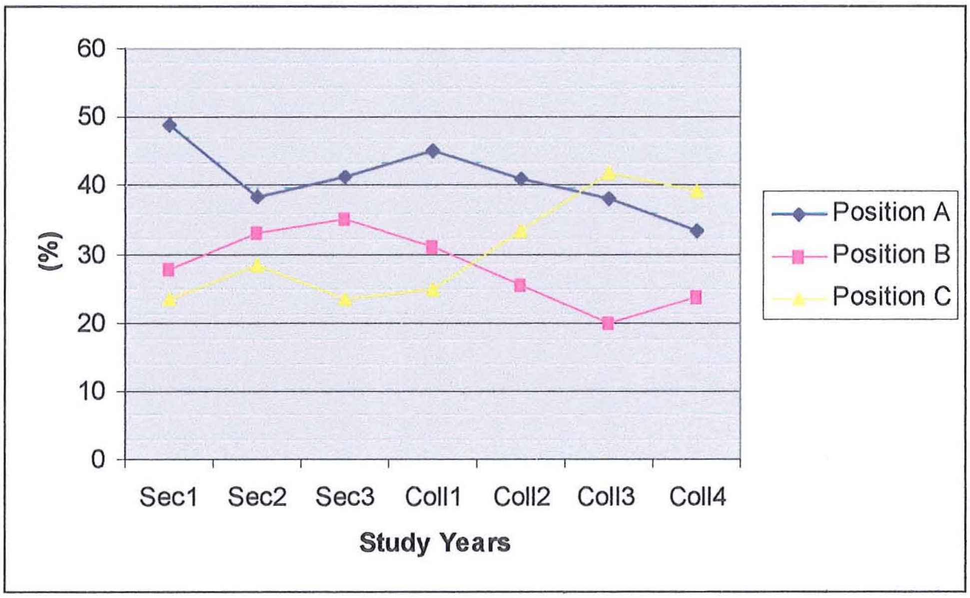


Figure 6.21: the percentages of students according to their positions and study years for question 7 part A

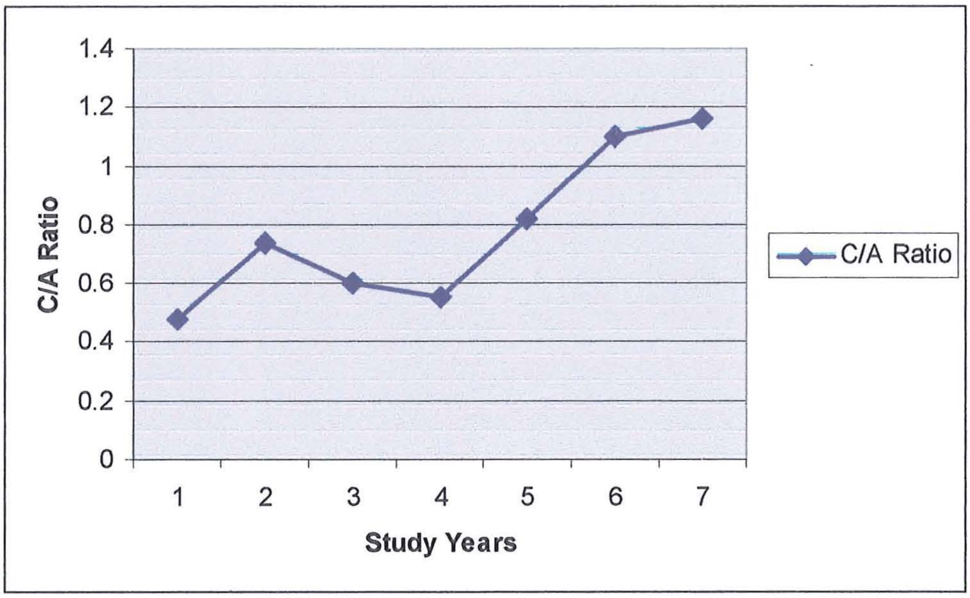


Figure 6.22: the C/A Ratio of students according to their study years for question 7 part A

Table 6.20: chi-square between different years for question 7 part A

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	9.830	3.204	8.489	8.582	7.524	3.412
d.f	5	5	5	5	5	5
P. value	.080	.669	.131	.127	.184	.637
Intellectual development	no	no	no	no	no	no

Table 6.19 and figures 6.21 and 6.22 show that with regard to scientific knowledge, it seems that most students are generally in position A and they think that scientific knowledge represents the absolute truth with just two exceptions: third year and fourth year in education colleges. It is also obvious that the percentages of students in B position for this question are relatively high for all years.

In secondary schools the percentages of students in C position shows a small increase in the second year and then a decrease in the third year. In education colleges there is a continuous increase from year one to year three followed by a decrease in the final year. However, chi-square results in table 6.20 show that none of these changes are significant. Generally college students are intellectually more developed than school students with regard to their responses to this question.

Part B. Q1. Sometimes there seem to be so many ways of looking at science that I feel confused about what is right and wrong

Table 6.21: the percentages of students according to their positions and study years for question 1 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	62.8	63.5	63.8	64.9	64.6	63.3	59.6
	B	27.6	30.8	24.1	21.5	25.3	22.9	19.3
	C	9.6	5.7	12.1	13.5	10.1	13.8	21.1
C/A Ratio		0.15	0.09	0.19	0.21	0.16	0.22	0.35

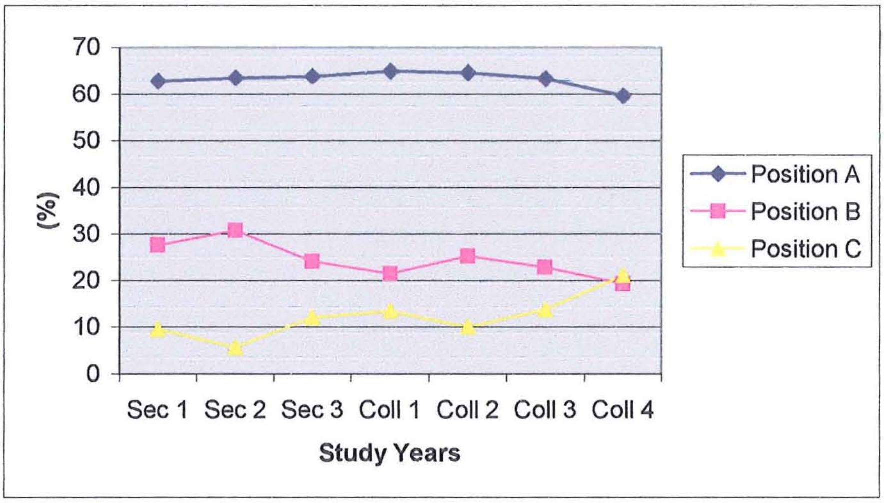


Figure 6.23: the percentages of students according to their positions and study years for question 1 part B

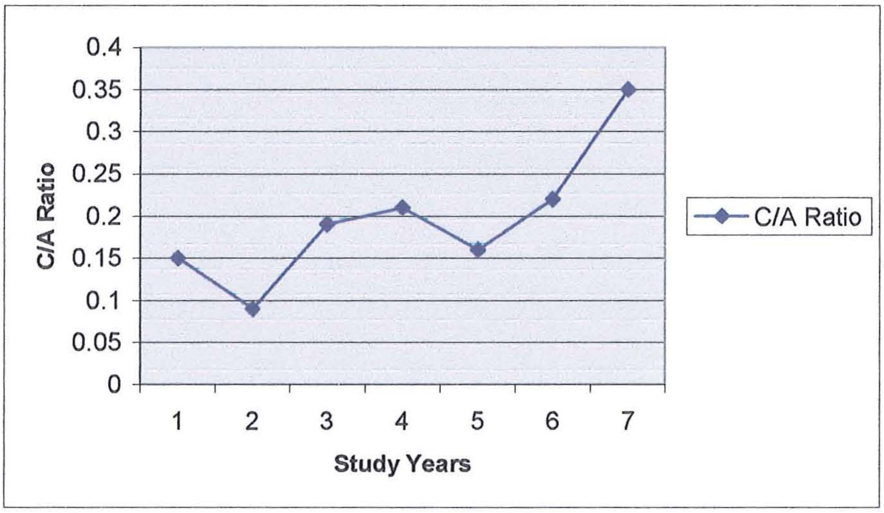


Figure 6.24: the C/A Ratio for students according to their study years for question 1 part B

Table 6.22: chi-square between different years for question 1 part B

	Compression between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	5.195	9.886	18.220	4.236	4.253	6.779
d.f	3	4	4	4	3	4
P. value	.16	.04*	.00**	.38	.24	.15
Intellectual development	no	increase	increase	no	no	no

Table 6.21 and figure 6.23 show that the percentages of secondary school students and education college students in C position are very low and college students' percentages are relatively higher than schools percentages. The majority of college students and school students are in A position but the percentages of those in A position in secondary schools increases over the study years while it decreases with college students. The percentages of students in B position are relatively high especially in secondary schools. The results show also that there is a continuous increase in the percentages of students in C position over the years with just two decreases, one in second year in secondary schools and the other in the third year in education colleges. In figure 6.24 the C/A ratio shows the same pattern for C position percentages in figure 6.23. However, chi-square test results in table 6.22 show that there are two significant changes: between second year and third year in secondary schools ($p = .04$) and third year in secondary schools and first year in education colleges ($p = .00$). The change between second and third years in secondary schools could refer to the awareness among students in the final year of the importance of dealing with situations where there are many ways to look at science in order to get a high grade. The increase between the third year in schools and first year in education colleges may be related to the experience they got in these colleges or to the difference between two populations.

Part B. Q5. It is a waste of time to work on problems which have no possibility of producing a clear-cut, unambiguous answer

Table 6.23: the percentages of students according to their positions and study years for question 5 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	41.9	40.3	36	35.8	38.7	45.3	42.7
	B	21.2	20.1	22.2	21.2	23.5	18.7	20.2
	C	36.9	39.5	41.8	42.9	37.8	36	37.1
C/A Ratio		0.88	0.98	1.16	1.20	0.98	0.79	0.87

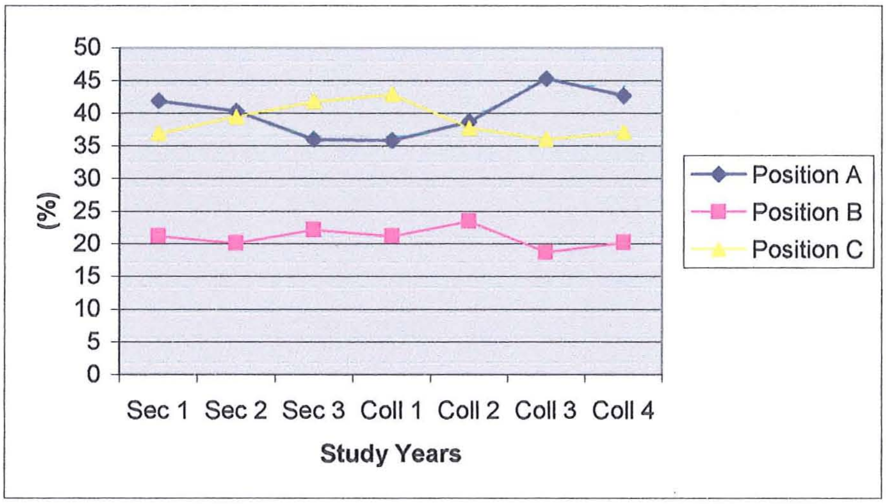


Figure 6.25: the percentages of students according to their positions and study years for question 5 part B

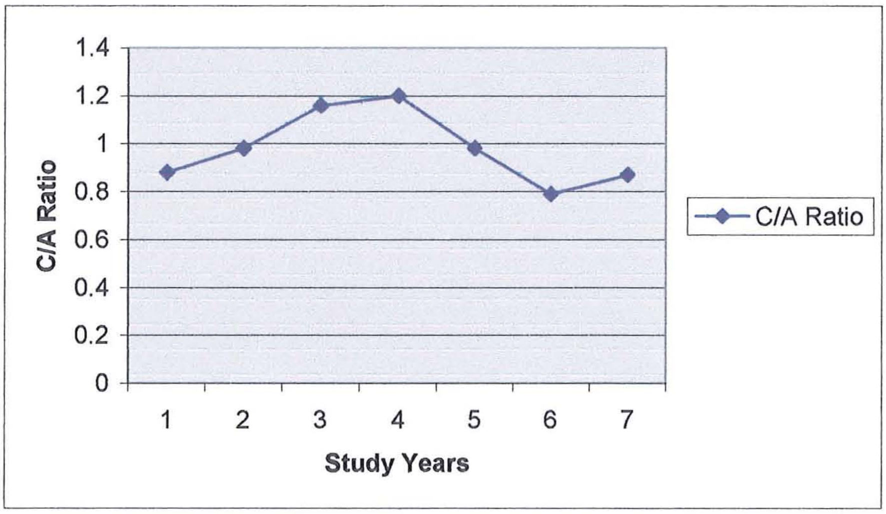


Figure 6.26: the C/A Ratio of students according to their study years for question 5 part B

Table 6.24: chi-square between different years for question 5 part B

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	2.6	3.2	13.7	4.9	2.6	1.9
d.f	4	4	4	4	4	4
P. value	.63	.53	.01**	.30	.64	.76
Intellectual development	no	no	increase	no	no	no

Table 6.23 and figures 6.25 and 6.26 show that most students are in Position A with the exception of third year in secondary school and first year in education college. Furthermore, from figure 6.26 it is noticed that there is increase in position C in years one, two and three in secondary school and first year in education colleges followed by a decrease on the following two years in the education college and an increase in fourth year. However, chi-square results in table 6.24 show that the only significant change is the increase between third year in school and first year in college ($p = .01$). With regard to students' percentages in B position, it is noticed that it is relatively high. However, it seems that in most questions related to students' perceptions of the nature of scientific knowledge, the students' percentage at C position is very low. In this question, position A is dominant during most of the seven years.

Part B. Q 7. A good thing about learning science is the fact that everything is so clear-cut: either right or wrong

Table 6.25: the percentages of students according to their positions and study years for question 7 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	48.4	50.2	43	47.2	33.8	31.6	42.7
	B	26.6	30.3	32.2	22.2	28.6	28.8	20.6
	C	25	19.5	24.8	30.6	37.6	39.5	36.7
C/A Ratio		0.52	0.39	0.57	0.65	1.11	1.25	0.86

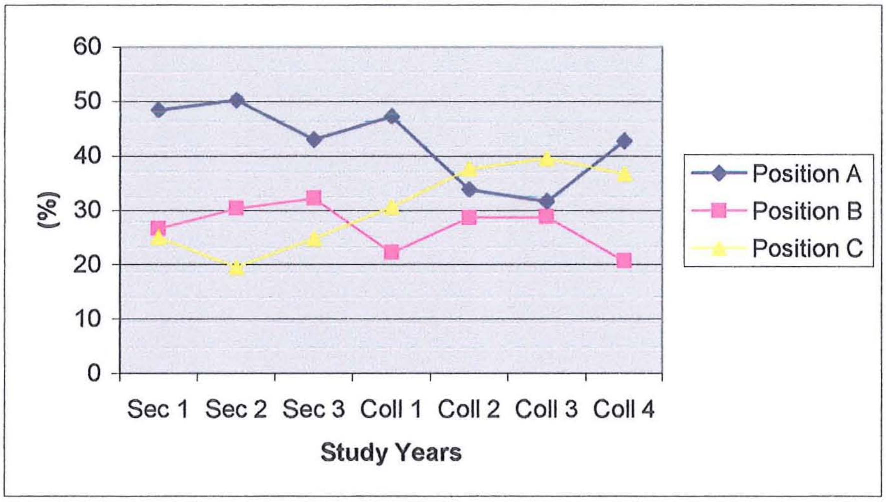


Figure 6.27: the percentages of students according to their positions and study years for question 7 part B

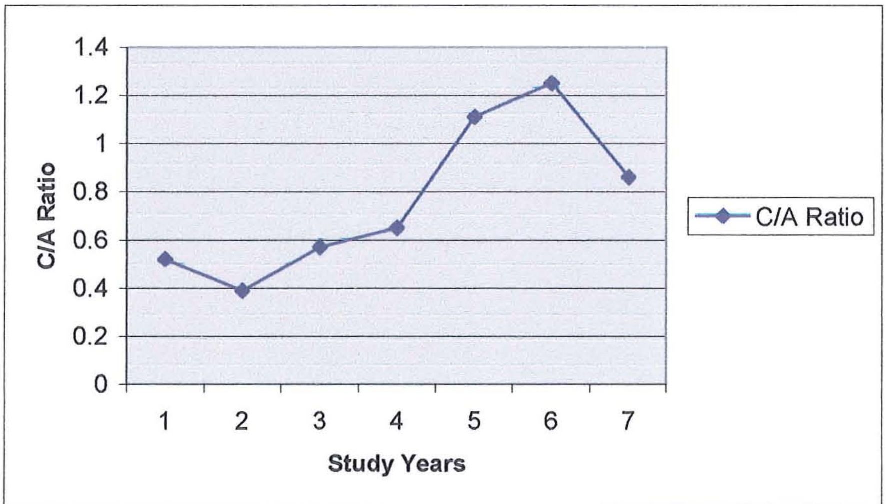


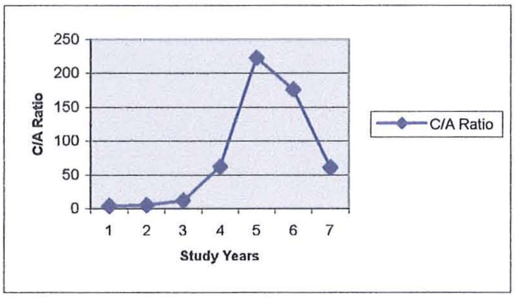
Figure 6.28: the C/A Ratio for students according to their study years for question 7 part B

Table 6.26: chi-square between different years for question 7 part B

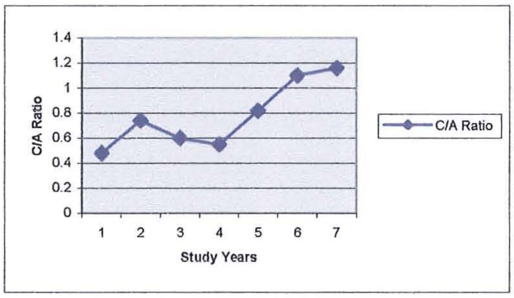
	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	4.8	2.9	6.9	9.6	2.7	8.0
d.f	4	4	4	4	4	4
P. value	.31	.58	.14	.05*	.61	.09
Intellectual development	no	no	no	increase	no	no

Table 6.25 and figures 6.27 and 6.28 show that most school students are in position A while in education colleges, just the students in first and fourth years are mostly in position A. Furthermore, college students are doing better in terms of intellectual development since all the percentages at C are larger than the percentages for school pupils. Figure 6.28 show that the C/A ratio decreases in second year in schools then it increases in the third year. It also increases in the first, second and third year in the college. In the fourth year it decreases. However, chi-square results in table 6.26 show that the only significant change is the increase between year one and two in the education colleges. Furthermore, percentages at B position are relatively high and percentages at C position are relatively low. The significant increase between year one and two in the education colleges may be related to the practicum experiences since the students start practicum at second year. There is a decrease in C/A ratio in the final year as was noticed from some previous questions.

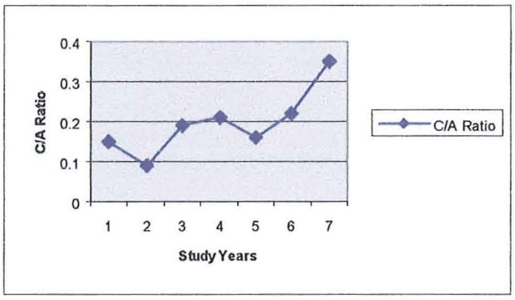
Summary



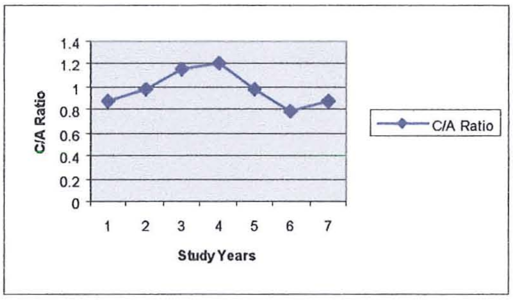
Question 6 part A



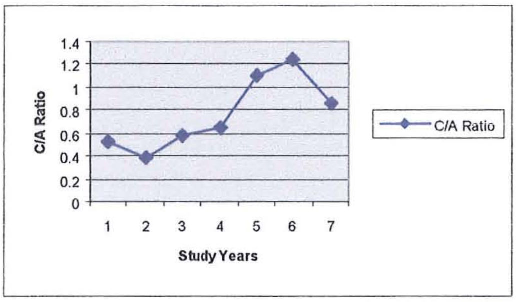
Question 7 part A



Question 1 part B



Question 5 part B



Question 7 part B

Figure 6.29: the C/A Ratio for students according to their study years for questions related to students' perceptions about the nature of scientific knowledge

As an answer to the question raised before about the changes in the students' perceptions about the nature of the scientific knowledge and from figure 6.29, it can be said that apart from question six part A in the questionnaire, it seems that the percentages of C position students in those questions related to their view of knowledge is very low. Most of students in both schools and colleges think that the scientific knowledge is either right or wrong and the scientific knowledge just represents the "absolute truth". The percentages of students in C position in colleges were as low as 10.1% to 21.1 % and, in schools, 5.7% to 12.1%. These are very low indeed. However, question six part A may be different because it does not ask directly about the nature of relatively nature of scientific knowledge.

It is also clear that if question six part A is excluded, most students are in position A and there are relatively high percentages of students in position B (which seems to be an uncomfortable position for students) with regards to questions related to the nature of scientific knowledge. In some study years in secondary schools the percentage of students in B position is as high as 35% and in education colleges is as high as 31%. The high percentages of students in B position in questions related to the nature of scientific knowledge can be explained in terms of the students' doubts about the nature of scientific knowledge. It seems that there are good percentages of students who do not accept the A view of scientific knowledge but they do not have enough confidence to make up their minds and move to position C view.

Generally, for these questions related to students perceptions about the nature of scientific knowledge, the percentages of students in the C position increase over the study years in the education colleges with just one exception in question five part B. Although there are some different patterns in different questions in secondary schools, the general pattern is the increase of students percentages in C position over their study years. If schools and colleges percentages are considered together, it can be said that generally there are increases in the percentages of students in position C, which reflects the continuous improvement of students' perceptions of the nature of scientific knowledge.

Although there is slight improvement on the students' perceptions of the nature of the scientific knowledge, the percentages of students in C position at any year of their study in secondary schools or education colleges are still low. In four out of five questions, the percentages are less than 50%. This may reflect the rigid views of the scientific knowledge among many of colleges' students. This raises important questions about the way of teaching, which will be used by those students after their graduation from these colleges. For many of them, they will deal with it as absolute truth rather than relative truth. It is possible that students who demonstrate C type characteristics in Perry scale will also tend to be more open-minded and more willing to be critical.

6.5 STUDENTS' PERCEPTIONS OF ASSESSMENT

How do the students' perceptions of assessment change over their study years in the education colleges?

Part A. Q8. I do not like short questions as they do not give me the chance to explain what I know and understand / I prefer to learn the facts and then be tested on them in short questions

Table 6.27: the percentages of students according to their positions and study years for question 8 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	52	47.3	49.1	43.1	41.2	45.8	41.7
	B	22	25.4	27.6	23.9	25	23.4	26.4
	C	26	27.3	23.3	33	33.8	30.8	31.9
C/A Ratio		0.5	0.58	0.47	0.77	0.74	0.67	0.76

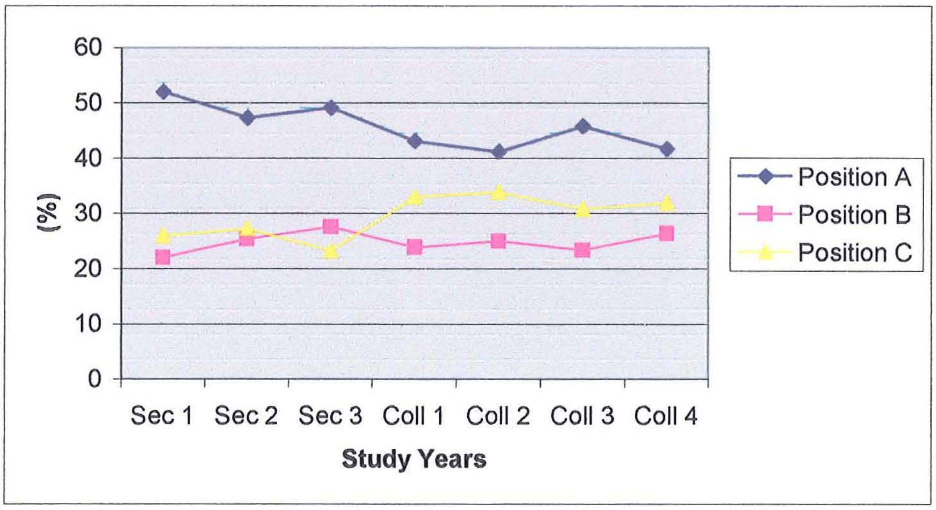


Figure 6.30: the percentages of students according to their positions and study years for question 8 part A

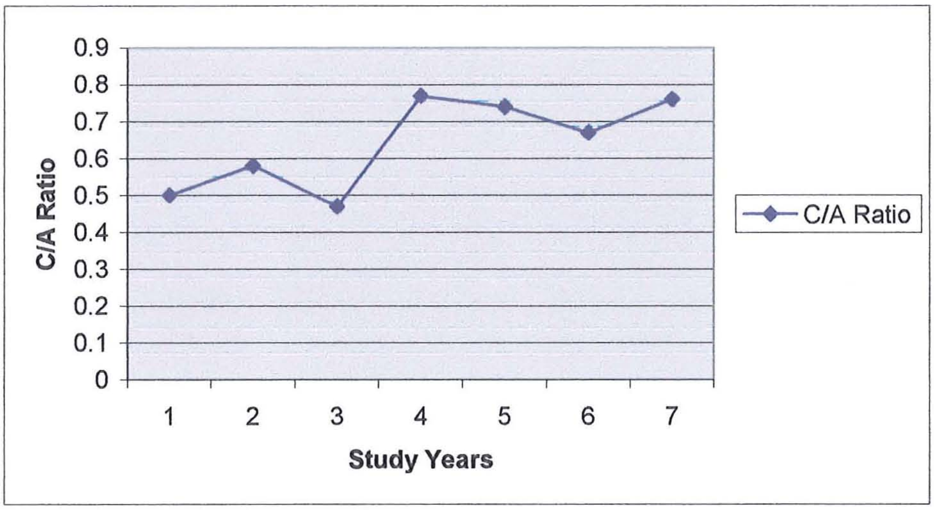


Figure 6.31: the C/A Ratio for students according to their study years for question 8 part A

Table 6.28: chi-square between different years for question 8 part A

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	2.8	5.9	7.5	6.6	3.2	6.0
d.f	5	5	5	5	5	5
P. value	.73	.31	.18	.26	.67	.30
Intellectual development	no	no	no	no	no	no

It is clear from table 6.27, figure 6.30 and figure 6.31 that most students are in position A with regard to this question and college students do slightly better than school students. Furthermore, the C/A ratios in figure 6.31 show that there is a slight improvement in intellectual development between year one and two in secondary school, a decrease between years two and three in secondary school then an increase between third year in schools and first year in education colleges followed by a slightly decrease between first and second year in the education college and second and third year in college. Then there is an slight increase in the fourth year. However, chi-square results in table 6.28 shows that there are no significant changes between years showing that the trend is a gradual one. Table 6.27 and figure 6.30 shows that the pattern of the changes of the percentages of students in position C over their study years is similar to pattern of changes in C/A ratio. They also show the relativity higher percentages of students in B position and the low percentages of students in position C. Figure 6.31 also shows that there is an increase between the final year in schools and the first year in the education colleges, which may due to the colleges experience or to the population changes.

Part A. Q9. In exams I prefer questions which are based on what the lecturer taught / In exams, I like questions that give me the scope to go beyond what is taught and show my ability to think

Table 6.29: the percentages of students according to their positions and study years for question 9 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	57.4	61.3	62.2	55.2	52.4	50.7	46.6
	B	21.5	16.7	16.3	26.9	25.8	25.1	16
	C	21.1	21.9	21.5	17.9	21.8	24.2	37.4
C/A Ratio		0.37	0.36	0.35	0.32	0.41	0.42	0.80

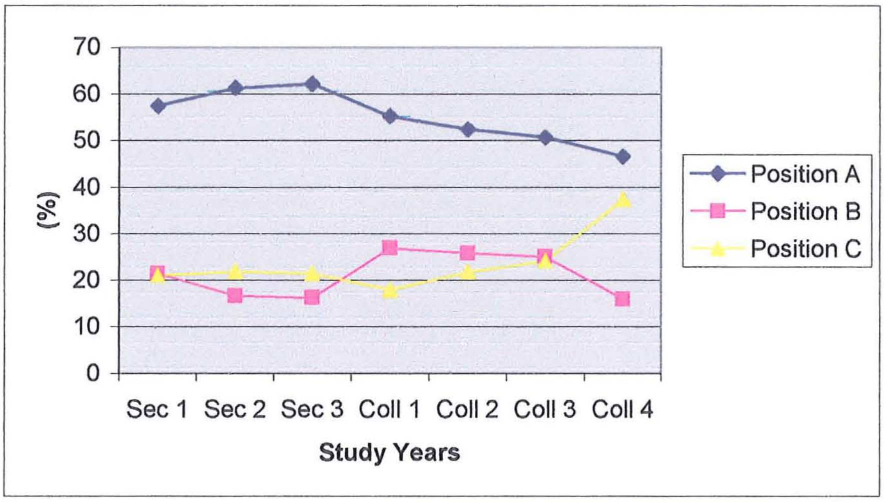


Figure 6.32: the percentages of students according to their positions and study years for question 9 part A

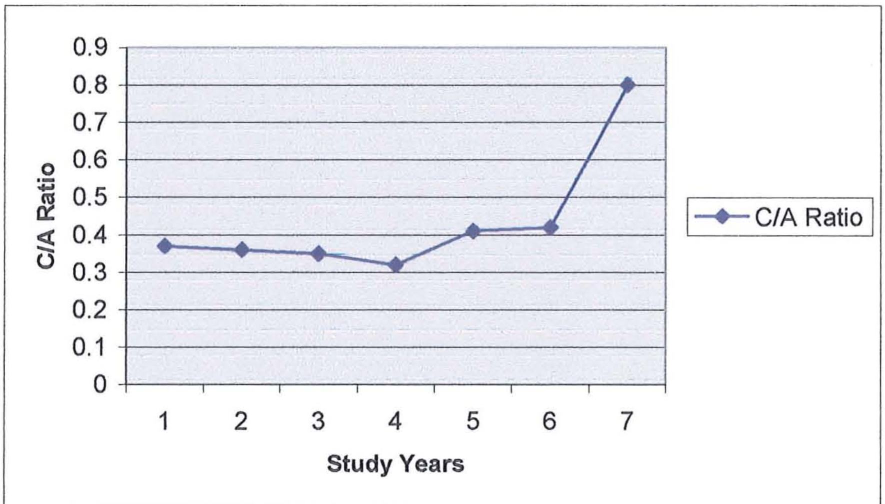


Figure 6.33: the C/A Ratio for students according to their study years for question 9 part A

Table 6.30: chi-square between different years for question 9 part A

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	8.3	1.5	8.3	2.2	2.8	16.3
d.f	5	5	5	5	5	5
P. value	.14	.91	.14	.82	.73	.01**
Intellectual development	no	no	no	no	no	increase

The results from table 6.29 and figures 6.32 and 6.33 show that most students are in Position A although the number of C position students are increasing generally as they progress through their study years from first year in secondary school to fourth year in education college. Furthermore, figure 6.33 shows that there is a slight decrease in C/A ratio between second and third years in the secondary school and first year in education college but then it shows an increase in the following three years in education college. However, chi-square results in table 6.30 shows that the only significant change is the increase in the C/A ratio between year three and four in the education college (p = .01). Results also show the relatively high percentages of students at B position. On the other hand, college students generally have better perceptions about assessment than school students but both of them still have low percentages at C position. In this question there is a significant increase in the final year. At this stage, students are beginning to think about assessment as they will use it in their own teaching and less for themselves.

Part A. Q10. I believe that what should matter in exams is the quality of my answers, not how much I write \ In exams, I expect to be rewarded for giving as much information as possible

Table 6.31: the percentages of students according to their positions and study years for question 10 part A

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	31.5	37.5	28.2	27.5	15.2	16	25.2
	B	12.5	16.7	16.2	14.2	14.3	13.8	12.4
	C	56	45.7	55.6	58.3	70.4	70.2	62.4
C/A Ratio		1.78	1.22	1.97	2.12	4.63	4.39	2.48

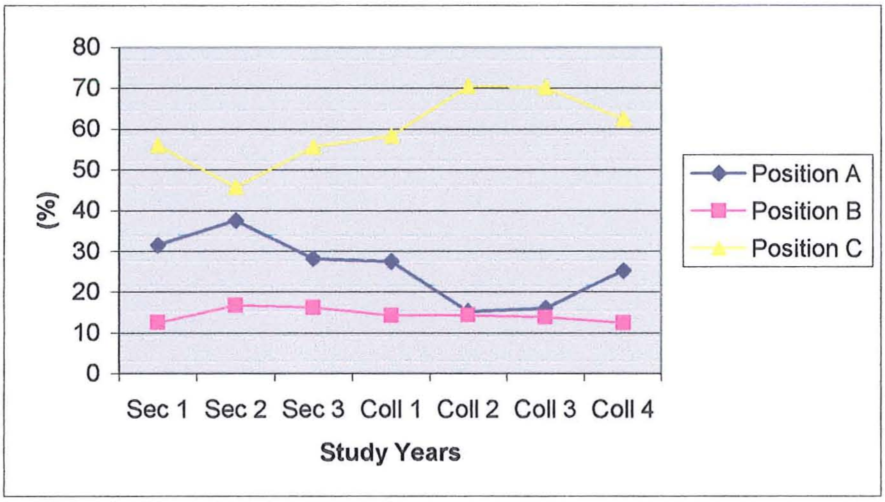


Figure 6.34: the percentages of students according to their positions and study years for question 10 part A

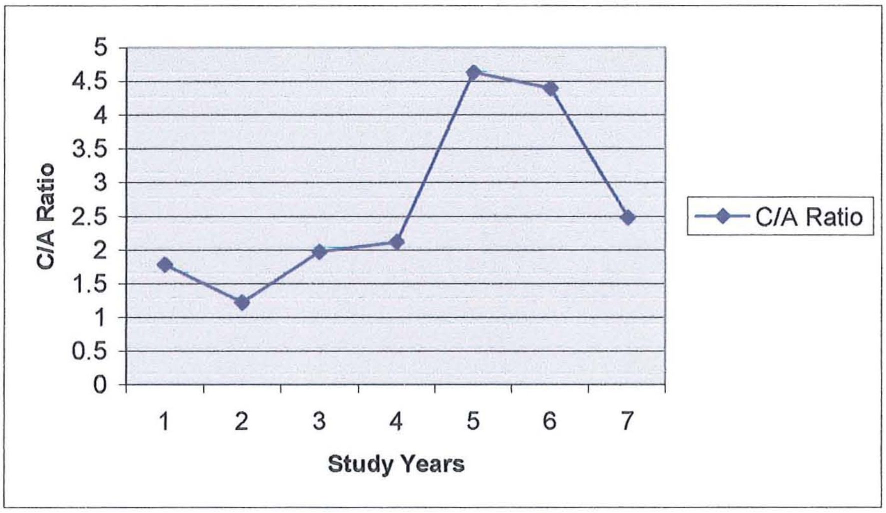


Figure 6.35: the C/A Ratio for students according to their study years for question 10 part A

Table 6.32: chi-square between different years for question 10 part A

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	8.3	8.6	1.1	12.9	1.7	9.6
d.f	5	5	5	5	5	5
P. value	.14	.12	.95	.02*	.88	.09
Intellectual development	no	no	no	increase	no	no

Table 6.31 and figure 6.34 shows that most students are in position C with regard to this question and college students are doing better than school students as the highest percentage for school students is 56% in first year and the lowest percentage for college is 58.3% in the first year and it rises up to 70.4% in the third year. Furthermore it can be seen from figure 6.35 that the ratio of C/A (which reflects the intellectual development) decreases in second year in secondary school and increase in third year and rise again in first and second years in college then there are slight decreases in third and fourth year. However, chi-square test in table 6.32 shows that the only significance difference is the increase between first and second years in the education college ($p = .02$). This may be due to the practicum experience. Finally, in this question colleges students seem to have better perceptions about the assessment of science.

Part B. Q4. If I have the choice of written comments or a specific mark at the end of a piece of science coursework, I would choose the comments

Table 6.33: the percentages of students according to their positions and study years for question 4 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	36.9	39.5	18	12.8	13.5	12.2	12.8
	B	21.2	20.1	19.7	19.4	20.1	13.7	26.6
	C	41.9	40.3	62.3	67.8	66.4	74.1	60.5
C/A Ratio		1.13	1.02	3.46	5.30	4.92	6.07	4.73

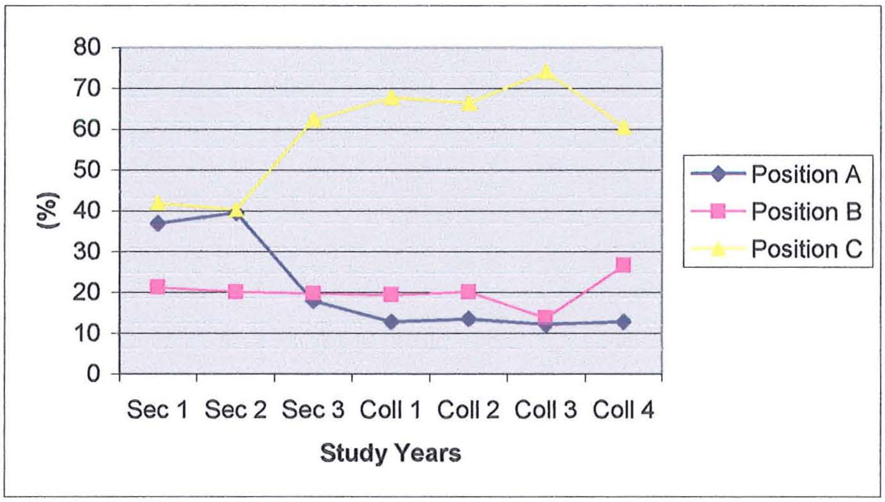


Figure 6.36: the percentages of students according to their positions and study years for question 4 part B

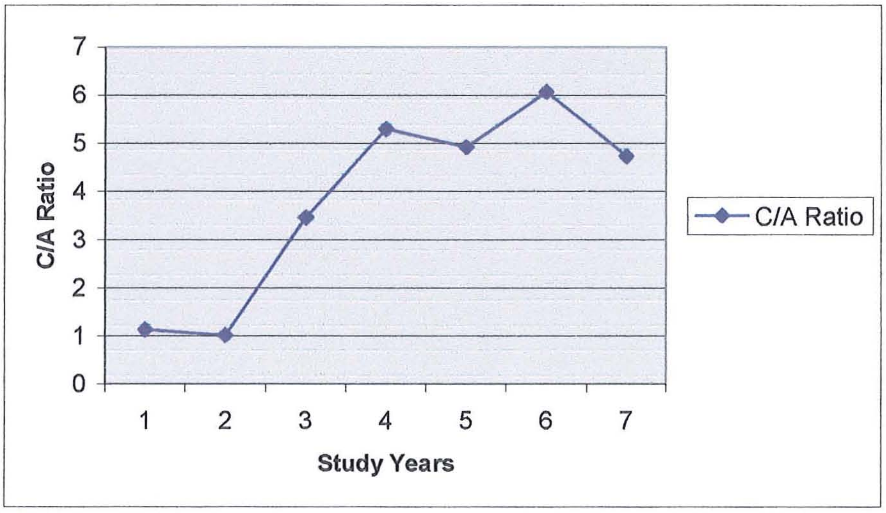


Figure 6.37: the C/A Ratio for students according to their study years for question 4 part B

Table 6.34: chi-square between different years for question 4 part B

	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	5.5	2.6	5.0	1.1	8.3	14.8
d.f	4	4	4	4	4	4
P. value	.24	.62	.29	.90	.08	.01**
Intellectual development	no	no	no	no	no	decrease

The results from table 6.33 and figures 6.36 and 6.37 show that most students with regard to this question are in position C and colleges' students in general do better in terms of intellectual development in this question. From figure 6.37, it is noticed that there is a very small decrease in intellectual development in second year of secondary school, followed by an increase in third year and first year of education colleges. Furthermore, there is a decrease in second year in college followed by an increase in third year. In fourth year in education colleges, there is a decrease and it is the lowest percentage of students in C position among the study years in the education colleges. However, chi-square results in table 6.34 show that the only significance change is the decrease between the third and fourth years in the education colleges (p = .01).

Part B. Q8. I like exams which give me an opportunity to show I have ideas of my own

Table 6.35: the percentages of students according to their positions and study years for question 8 part B

		Secondary schools years			Education colleges years			
		1	2	3	1	2	3	4
Position (%)	A	8.4	10.1	13.7	7.9	3.9	2.7	7.2
	B	6.8	6.3	4.7	15.3	6.5	6.8	6.7
	C	84.9	83.6	81.5	76.9	89.6	90.4	86
C/A Ratio		10.11	8.28	5.95	9.73	22.97	33.48	11.94

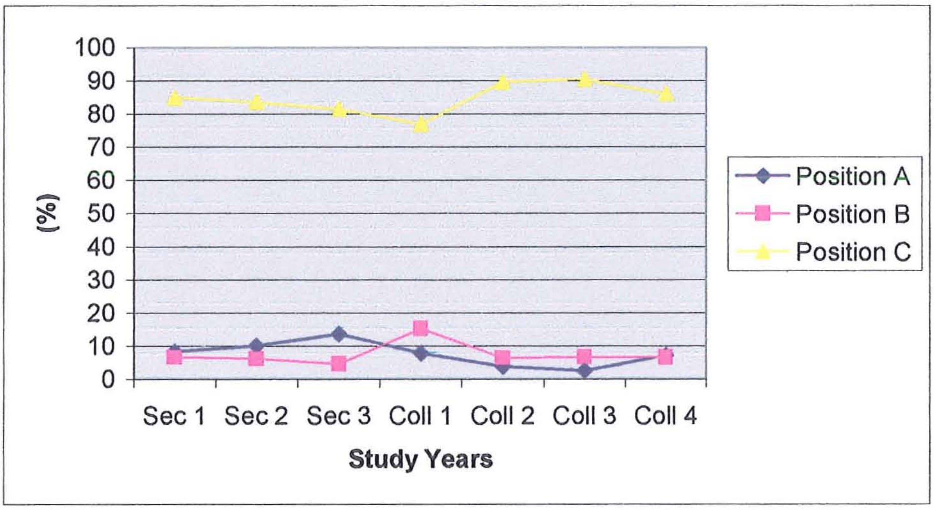


Figure 6.38: the percentages of students according to their positions and study years for question 8 part B

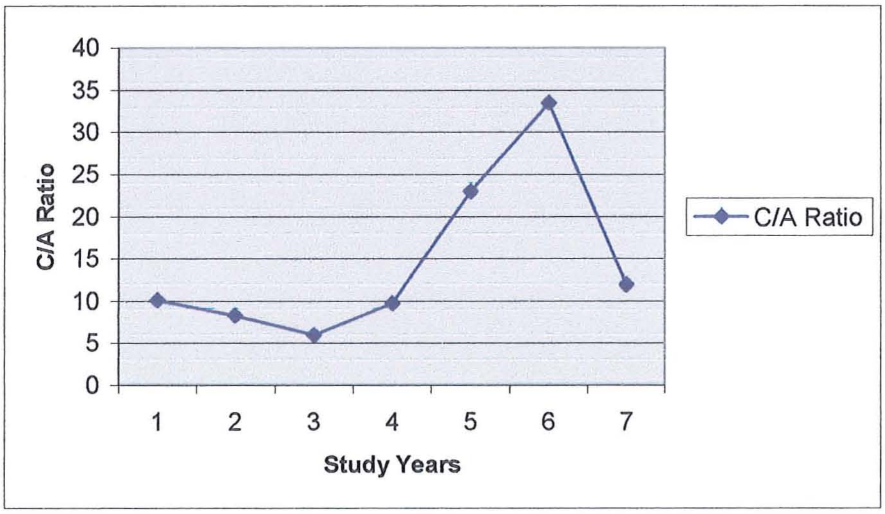


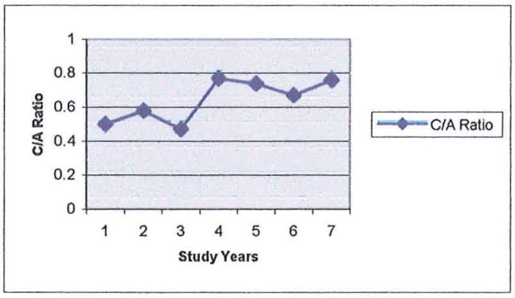
Figure 6.39: the C/A Ratio for students according their study years for question 8 part B

Table 6.36: chi-square between different years for question 8 part B

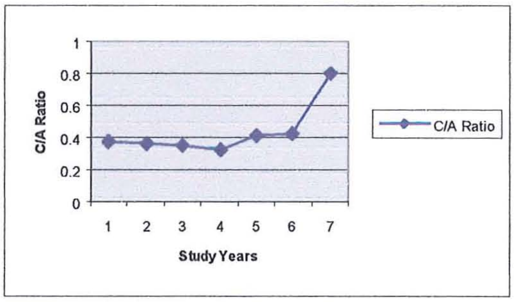
	Comparison between					
	1sec–2sec	2sec-3sec	3sec-1col	1col-2col	2col-3col	3col-4col
Chi-square	2.0	6.1	11.474	6.1	.9	5.4
d.f	4	4	4	3	3	3
P. value	.73	.19	.02*	.11	.82	.14
Intellectual development	no	no	increase	no	no	no

Table 6.35 and figure 6.38 show that most students with regard to this question are in position C and college students are doing better than secondary schools' students in terms of intellectual development. Figure 6.39 shows that there is decrease in C/A ratio in second and third years in secondary schools followed by increase in year one two and three in education colleges. In fourth year there is a decrease. Chi-square results from table 6.36 show that the only significant change is the increase between third year in school and the first year in education college (P = .02). This change may be related to difference between populations or to the experience they gain at these colleges. This may arise because students are given relatively higher opportunities to show their own ideas in the education colleges.

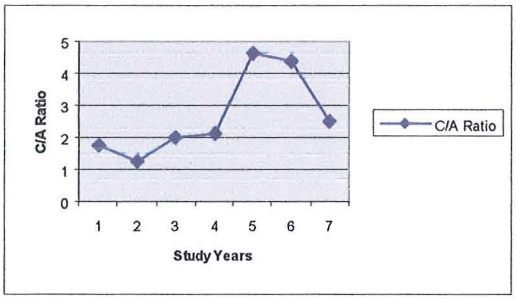
Summary



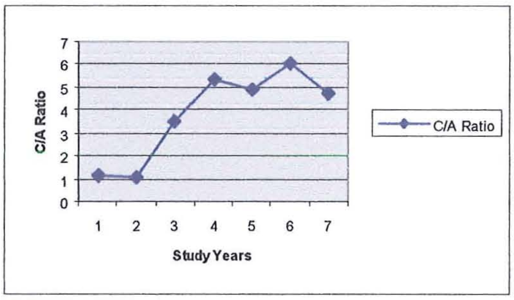
Question 8 part A



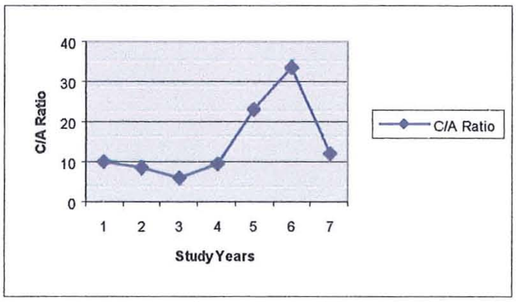
Question 9 part A



Question 10 part A



Question 4 part B



Question 8 part B

Figure 6.40: the C/A Ratio for students according to their study years for questions related to students' perceptions about the assessment

Looking at the changes in students' perceptions about assessment over their study years in the education colleges, it can be said that, in general, college students have better perceptions about assessment than those at school.

The results show also that, in three out of five questions, most students were in the C position. In some of these questions, the percentages went up to more than 90%, which indicate the high level of students intellectual development in some questions related to assessment. On the other hand, the results of the other two questions (question 8 part A and question 9 part A) showed the opposite view. In these questions the percentages of students in the C position is very low indeed and the percentages of students in B position were relatively high. It seems that students mainly like to learn the facts and then be tested on them in short questions and prefer questions which are based on just what the (lecturer\teacher) taught. Furthermore, they do not like questions, which go beyond what was taught, to show students ability to think.

The results revealed some contradictory views among students. For example in questions 8 part B very high percentages were in position C and they like exams which give them opportunity to show that they have their own ideas but in questions 8 part A, students like to learn facts which only has been taught lecturers and then test on them on short questions which is not a good way to give the opportunity from them to show their ability to think. It seems that students like the idea of showing their ability to think by themselves but when it come to practical part where they have to be tested they prefer to be tested by questions represent A position.

Many of previous studies show that the students tend to be negative (they are mainly in A position) in terms of the Perry scheme on assessment issues. This may due to the students' view of assessment as the final outcome of educational process. That makes them prefer the easiest way to achieve the highest level. Thus, they prefer the clear-cut way, which is based on short questions and those questions which are just based on what the lecturer taught.

6.6 STUDENTS' INTELLECTUAL DEVELOPMENT

Has the student's intellectual development improved as they go from year one in secondary school to final year in Education College?

The previous results showed that the general trends in most questions that students perceptions of learning improve over their study years. To explore this relation further Kendall's tau-b test was applied between students' years and their responses to their questionnaires. The using of Kendall's tau-b correlation will be discussed in appendix (J). In essence, it is a correlation technique where data are in a few categories. First year in secondary school was given one and the second given two and so on until the fourth year in the college was given seven. To find out if the intellectual development of the students improved as the students go through these seven years students intellectual development for part A questions will give a value from 1 to 6, one will be for students who choose the nearest box to A statement and six to student who choose the nearest box to C statement.

In part B of the questionnaires, if the statement represents position A, strongly agree will be given 1, agree 2, uncertain 3, disagree 4 and strongly disagree 5. If the statement represents C statement, strongly agree will be given 5, agree 4, uncertain 3, disagree 2 and strongly disagree 1. By using Kendall's tau-b correlation relationship between numbers of years students study from secondary one to the last year in education colleges and their intellectual development is tested through the score given to each response. Kendall's tau-b merely treats these as ordered categories. The results of that are shown in tables 6.37 and 6.38.

Table 6.37: the correlation between the students' year of study and their intellectual development (part A of the questionnaires)

Question	1	2	3	4	5	6	7	8	9	10
Correlation coefficient	.038	.067	.233	-.024	.087	.079	.075	.046	.081	.121
P. value $N \approx 1500$ (2-tailed)	.06	.00**	.00**	.23	.00**	.00**	.00**	.02*	.00**	.00**

** correlation is significant at 5% level (2-tailed test)*

*** correlation is significant at 1 % level (2-tailed test)*

Table 6.38: the correlation between the student's year of study and their intellectual development (part B of the questionnaires)

Question	1	2	3	4	5	6	7	8
Correlation coefficient	.067	.057	.140	.045	-.043	.069	.093	-.006
P. value N ≈ 1500 (2-tailed)	.00**	.01**	.00**	.03*	.03*	.00**	.00**	.77

** correlation is significant at 5% level (2-tailed test)*

*** correlation is significant at 1 % level (2-tailed test)*

The results in table 6.37 and table 6.38 show that in 14 out of 18 questions there are significant positive correlations and only one negative correlation between students' intellectual development (in question 5 part B) and their progress through their study years. Thus, there are improvements in students' intellectual development as they progress during their study from year one in secondary school to final year in the college. However, tables 6.37 and 6.38 shows that, although the correlation coefficients are small, they are very significant. This is related to the high sample size. Furthermore, the populations (secondary school's pupils and education college's students) are two different populations so the results from that should be accepted with some caution.

The only negative significant correlation is in question 5 part B, which represents students' perceptions of scientific knowledge. The results show that the questions which showed no significant correlation are distributed over three main areas: one in students' perceptions of students role, one in students perceptions of lecturers' role and one in students' perceptions of assessment.

The results also support the general trends observed in C/A ratio. Thus, it can be stated that there is an improvement in students' intellectual development.

6.7 INTELLECTUAL DEVELOPMENT AND ACADEMIC PERFORMANCE

What is the relationship between colleges students' academic performance and their intellectual development?

In order to answer this question, Kendall's tau-b was used to find out the correlation between students' academic performance and their intellectual development. Students' intellectual development for each question will be scored as it showed in previous question. Students' performance will be measured according to students GPA (a scale used in education colleges to measure students' performance which is from 0 to 4 points) that is obtained from students' colleges. This analysis is just for colleges' students and the results are shown in the following tables.

Table 6.39: the correlation between academic performance and students' intellectual development (part A of the college questionnaire)

Question	1	2	3	4	5	6	7	8	9	10
Correlation coefficient	-.004	.107	.137	.031	.013	.207	.114	-.025	-.003	.143
P. value N ≈ 870 (2-tailed)	.94	.04*	.01**	.053	.80	.00**	.02**	.61	.96	.00**

** correlation is significant at 5% level (2-tailed test)*

*** correlation is significant at 1 % level (2-tailed test)*

Table 6.40: the correlations between academic performance and students, intellectual development (part B of the college questionnaire)

Question	1	2	3	4	5	6	7	8
Correlation coefficient	-.089	-.097	.068	.091	-.085	.111	.059	-.041
P. value N ≈ 870 (2-tailed)	.08	.06	.17	.07	.09	.03*	.23	.43

** correlation is significant at 5% level (2-tailed test)*

*** correlation is significant at 1 % level (2-tailed test)*

From table 6.39 and table 6.40 show that there are significance positive correlations between students academic performance and the intellectual development with regard to these questions:

- I do not believe in just accepting what the lecturer says without question. Success involves thinking for myself \ I cannot be wrong if I accept what the lecturer says. If I question anything, I might end up failing (question 2 part A).

- I believe it is the job of the lecturer to supply me with all the knowledge I need \ The duty of the lecturer is not to teach me everything, but to help me to think for myself (question 3 part A).
- All one has to do in science is to memorise things \ Understanding science is the key part of science study (question 6 part A).
- I do not believe that all scientific knowledge represents the 'absolute truth' / We cannot call anything scientific knowledge if it is not absolutely true (question 7 part A).
- I believe that what should matter in exams is the quality of my answers, not how much I write \ In exams, I expect to be rewarded for giving as much information as possible (question 10 part A).
- I feel uncomfortable when I am left to express an opinion, not knowing the view the lecturer feels (question 6 part B).

The results showed that in 6 out of 18 questions the colleges' students academic performance positively correlate with students' intellectual development. Furthermore, these six questions were from all four main areas of Perry scheme of intellectual development. A trial attempt was made to find out common things between the questions which have significant correlations or between questions which have no significant correlations and there are nothing really common about any of them.

6.8 INTELLECTUAL DEVELOPMENT AND GENDER

Is their any significant difference between male and female in term of their perceptions of learning?

To answer this question, chi-square (χ^2) as a contingency test was applied to find out if there is a significant difference between males and females for the whole student group in terms of their perceptions of learning. The results are shown in tables 6.41 and 6.42.

Table 6.41: Chi-square between males and females in term of their perceptions of learning (part A of questionnaires)

Q	Chi-square (χ^2)	d.f	Sig. level	Intellectual development	
				Male > female	Female> male
1	38.6	5	.000**		✔
2	47.7	5	.000**		✔
3	103.5	5	.000**		✔
4	60.9	5	.000**		✔
5	33.8	5	.000**		✔
6	98.2	5	.000**		✔
7	11.0	5	.051		
8	10.3	5	.066		
9	28.2	5	.000**		✔
10	43.4	5	.000**		✔

Table 6.42: Chi-square between males and females in term of their perceptions of learning (part B of questionnaires)

Q	Chi-square (χ^2)	d.f	Sig. level	Intellectual development	
				Male > female	Female> male
1	41.0	4	.000**	✔	
2	19.8	4	.001**	✔	
3	50.0	4	.000**		✔
4	50.1	4	.000**		✔
5	12.9	4	.012*		✔
6	19.8	4	.001**		✔
7	26.6	4	.000**		✔
8	13.9	4	.008**		✔

The results show that the females are more likely to be intellectually developed than males since out of 18 questions, females are doing better than male in 14 of them. On the other hand males are doing better than females at in just two questions and there are no significant differences in two questions. This may be explained in term of their academic performance. The females' academic performance is generally better than males and, as is known from the literature, academic performance correlates positively with intellectual development (Byrne, 2001).

6.9 INTELLECTUAL DEVELOPMENT AND CURRICULUM AREA

Is there any significance difference between secondary art stream and science stream students' in term of their perceptions of learning?

In order to answer this question chi-square (χ^2) as a contingency test was applied between the responses of art and science students in secondary schools. The results are shown in tables 6.43 and 6.44.

Table 6.43: Chi-square between science stream students and art stream students in terms of their intellectual development (part A of questionnaires)

Q	Chi-Square	d.f	Sig. level	Students who are more likely to be more intellectual developed	
				Science	Arts
1	23.108	5	.000**	✔	
2	10.606	5	.060		
3	6.092	5	.297		
4	41.047	5	.000**	✔	
5	8.444	5	.133		
6	8.109	5	.150		
7	11.176	5	.048*	✔	
8	15.555	5	.008**		✔
9	29.327	5	.000**	✔	
10	17.499	5	.004**		✔

Table 6.44: Chi-square between science stream students and art stream students in terms of their intellectual development (part B of questionnaires)

Q	Chi-Square	d.f	Sig. level	Students who are more likely to be more intellectual developed	
				Science	Arts
1	2.592	4	.628		
2	9.867	4	.043*	✔	
3	1.848	4	.764		
4	13.201	4	.010**	✔	
5	15.141	4	.004**	✔	
6	16.438	4	.002**	✔	
7	2.113	4	.715		
8	5.829	4	.212		

The results in tables 6.43 and 6.44 show that 8 questions out of 18 questions science students are significantly more developed than arts stream students. It also shows that in just two questions, the arts stream students are more significantly developed than science stream students. Both these questions are related to their perceptions of assessment. The results here are consistent with the contextual nature of Perry scheme.

6.10 DISCUSSION OF THE RESULTS

The results indicated that, in general, most students have positive perceptions about lecturer's role and student's role at all ages and stages. This has been shown through the high percentages of them in position C. This may be due to the experiences students go through in education colleges, which help them to improve their perceptions about the student's role and lecturer's role. Students in these colleges go through teaching experience in practicum. Through this situation they recognize that, in order to teach science effectively, teachers should help their students to think for themselves and teachers should be facilitators. They also study some education and psychology courses, which may help them to realize the teacher's role and understand the nature of students' psychology. All these factors together make students think about what should they do as teachers to help their students to understand science, and what students should do to achieve this aim. It could be that finally the majority of them come up with the conclusion that in order to teach science effectively the teacher's role should be as a facilitator and students should be active learners. Furthermore, teaching methods adopted in these colleges may affect college students' perceptions of the lecturer's role and the student's role and make them have positive perceptions especially in educational and psychological courses. Lecturers in these colleges are encouraged to use student based teaching methods. In these teaching methods, students are active learners' and the lecturer's role is to facilitate students learning.

With regard to college students' perceptions of science assessment, the results show that in some questions, students have positive perceptions about most issues of assessment. Students think that the assessment should assess the students' ability to think and they also think that the quality of answer is more important than the quantity of the answer. On the other hand in two of five questions, students have negative perceptions about assessments. It seems that students want to be assessed in just what has been taught by lecturers through short questions although they think in the previous three questions that the assessment should assess their ability to think. This may suggest that students see the importance of assessing students' ability to think and the importance of rewarding the quality of the answers but when it comes to exams they prefer to be assessed in a convenient way from their point of view. Students may choose this because the assessment for them is the key part of education process and it is the final outcome of it, which will affect their future. In general if these two questions are excluded, it can be said that college students have positive perceptions about science assessment. However, some previous studies (Moey, 1994; Seleping, 2000) showed that students perceptions were negative whereas in this study in the majority of questions related to assessment, students' perceptions in general are positive and the percentages of students in C position are relatively high.

A real problem was shown in college students' perceptions of the nature of scientific knowledge. The analysis has shown that most students for most questions about the nature of scientific knowledge are in position A. It seems that students in education colleges view scientific knowledge as white or black; right or wrong. Furthermore, the percentages of students in B position are relatively high, which suggests uncertainty and confusion. This may result from teaching science mainly as factual knowledge. In order to help our students to have positive perceptions about scientific knowledge and to view scientific knowledge as open to change and modification as a result of new experimental evidence, students need to be exposed to situations where there can be more than one answer to a scientific issue. It appears that the idea of absolute truth has been encouraged through the teaching methods used and through the ways in which scientific knowledge is presented to the students. Furthermore, it may be that the assessment methods used may affect students' perceptions of the nature of scientific knowledge. The use of assessment methods which emphasise A behaviours may lead students to construct negative perceptions about the nature of scientific knowledge. Fixed answer questions used in assessment could help in building negative perceptions in students' minds about the nature of scientific knowledge. Teaching science as a body of scientific knowledge may encourage students to have negative perceptions about the nature of scientific knowledge. Haider (1999) argued that most teacher preparation programmes in Arab countries focus on teaching about the body of scientific knowledge accompanied by selected education courses.

Many lecturers may suggest that by teaching science, their students will understand the nature of scientific knowledge. The findings may suggest that this is not always true. It seems that students concentrate on science as a body of knowledge. Moreover, when they are processing scientific knowledge in their working memory they possibly do not give attention to the nature of scientific knowledge and they may consider it as a noise. This may lead us to suggest that in order to help students to develop positive perceptions about the nature of scientific knowledge, learning situations should be arranged in such a way where the nature of scientific knowledge takes part in students' working memory when they deal with scientific knowledge.

It is clear from the results that the general patterns of C/A ratio over the study years and the percentages of students in C position show that there is a growth in students intellectual development over the years. Furthermore, Kendall's tau-b correlation results indicate similar patterns with just one exception in a question related to students perceptions about the nature of scientific knowledge where there was a negative significant correlation. This is stressed in the problem of students' perceptions of the nature of scientific knowledge. This growth in students' intellectual development agrees with what has been said in literature (Perry, 1999) although in some questions this growth is very low.

The results show also that the students' intellectual development generally declines in the final year of their study at education colleges. This may be due to the fear of their future after they graduate from these colleges. Selepeng (2000) explains that usually students' intellectual development tends to decline when students feel that they will move to new situation. It is worthwhile to note that her study showed the same pattern.

The Kendall's tau-b correlations between students academic performance and students intellectual development showed that in 6 questions out of 18 questions there were significant positive correlations. This agrees with the study carried out by Byrne (2001) and indicated that the students performance correlated positively with students intellectual development.

The results indicate that females in general are more likely to be more intellectually developed than males. This may be explained in term of their academic performance. The females' academic performance is generally better than males and, as is known from the literature, academic performance correlates positively with intellectual development (Byrne, 2001). It seems that there is nothing in common between these questions or between other 12 questions, which have no significant correlations.

The results show also that science stream students in secondary schools were generally more intellectually developed than arts stream students. This can be explained in term of the contextual nature of intellectual development. Because of that it is clear that those who choose to do science stream tend to be more intellectually developed when it is put in a scientific context.

6.11 CONCLUSIONS

While it has to be acknowledged that, as with all work with questionnaires, questions ambiguity is very difficult to avoid, the following conclusions can be drawn:

- College students have better perceptions of learning than secondary schools students.
- There was growth in students' intellectual development over the study years.
- Students' perceptions of lecturer's role improved over their study years.
- Students' perceptions of student's role improved over their study years.
- Students' perceptions of assessment improved over their study years but their percentages in C position are very low in two questions.
- Students' perceptions of the nature of scientific knowledge improved over their study years but there was a real problem with the very low percentages of students in C position in most questions.
- Generally academic performance positively correlates with students' intellectual development.
- Female students are more intellectually developed than male students.
- Science stream students in secondary schools are more intellectually developed than arts students when it comes to the students' perceptions about learning science.
- There is a decline in students' intellectual development in the final year of their study at education colleges in many questions.

The problem of students' perceptions of the nature of scientific knowledge is the main area of concern. The use of curriculum materials to assist the students will be described in the next chapter.

CHAPTER SEVEN

CHAPTER SEVEN
METHODOLOGY TWO
FIELD EXPERIMENT

7.1 INTRODUCTION

The results of the baseline measurements showed that there were problems with students' perceptions of the nature of scientific knowledge. Most students were in position A in questions related to their view of the nature of scientific knowledge. They view scientific knowledge as absolute truth. For them scientific knowledge is either right or wrong, black or white.

The results also showed that there were some problems with students' perceptions about assessment. Students had positive perceptions in some questions about assessment and negative perceptions in others. However, their perceptions about assessment were generally much better than their perceptions about the nature of scientific knowledge.

Much assessment in the colleges tends to give credit for 'right' answers and there is limited scope for the demonstration of higher thinking skills, and almost no scope for critical debate and the challenging of ideas. Thus, the students view of assessment perhaps simply reflects their own experiences. In this, the pattern of assessment in the colleges is not too different from the assessment in much of higher education in general. Of course, changing the emphasis of college assessment might well change students' perceptions. However, this is not a practical proposition in a research context.

Inevitably, if assessment rewards the recall of information regarded as 'correct', then the student's view of the nature of knowledge, and, in particular, scientifically deduced knowledge, will tend to be 'black and while', reflecting a Perry position A.

The question then arises as to whether it is possible to modify student perceptions of knowledge and assessment by introducing learning experiences where the emphasis reflects Perry C behaviour. It was decided, then, to develop short teaching materials and see if these brought about any change in student perceptions. These materials were described as teaching units and the main emphasis in these materials was to develop more positive student perceptions about the nature of scientific knowledge since this had been identified as the main area of difficulty.

7.2 WHY EXPERIMENT

Elmes *et al* (1996) defined experiments as *"tests designed to arrive at a causal explanation"*. They also argue that an experiment is the production of a comparison by controlling the occurrence or nonoccurrence of a variable and observing the outcome. Robson (1994) also thinks that an experiment is the approach for getting at causal relationship and is more useful than other approaches. Gay (1981) goes further and stresses that the experimental method is the only research method which can test the hypothesis of cause-and-effect relationships. Furthermore, he thinks that it is the most valid approach for the solution of educational problems. It is difficult to see any other way by which causality can be demonstrated other than the conduct of well-designed experiment.

Fundamentally, the main aim is to test the presence of causal relationships. This is not easy in that any experiment for this purpose must be robust. There needs to be careful control of variables so that any observed changes are unlikely to be caused by extraneous factors. Laboratory experiments allow this kind of control more easily but, in field experiments, the control of variables is extremely difficult. Nonetheless, field experiments have the advantage of reflecting real life more easily and thus any outcomes may be more transferable. In such situations, the researcher must try to be aware of likely factors in order to control them and to minimize the effects of these factors.

The experimental method was used in this field study because of its effectiveness in testing the causal relationships. This study is trying to test the effects of the treatment (the teaching units) in developing the learning perceptions of colleges' students.

7.3 EXPERIMENTAL DESIGN

The aim of this part of the study is to see if the use of teaching materials over a short period of time has any effect on the development of students perceptions of:

- Lecturer's role;
- Student's role;
- Nature of scientific knowledge;
- Assessment.

In this part of this study, the 'before and after two-groups design' (Robson, 1994) was used. In this design two groups are chosen: experimental and control. A pre-test is given to both groups. Then the, experimental group is given a treatment and nothing is given to control group. After that, a post test is given to both groups (figure 7.1).

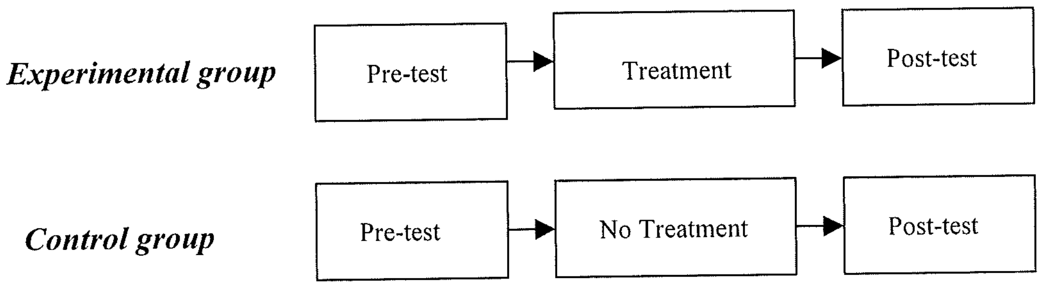


Figure 7.1: The before and after two groups design

Because the situation is known for both control and experimental groups before, changes in both groups can be compared.

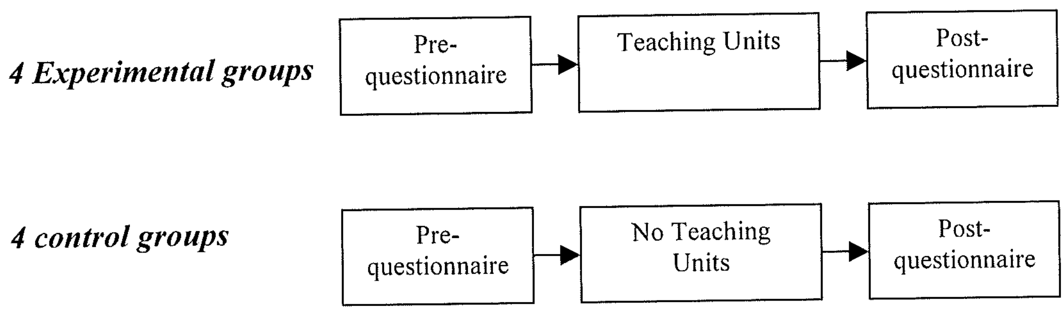


Figure 7.2: Experimental design for the field study

The questionnaire used in this study is the same one used in the baseline measurement with colleges' students. The teaching units will be discussed in the following section.

7.4 STUDY INSTRUMENTS

Several instruments were used in this study:

7.4.1 Questionnaire

The same questionnaire which was used in the first part of this study with college's students was used in this part as well.

7.4.2 Teaching Units

Five teaching units were developed, to be taught to the second year students in the education colleges. The general aim for these units is to help students to develop their perceptions of learning especially the perceptions of the nature of scientific knowledge since this was the major problem in the baseline measurements. The general characteristics of these units are:

- They are problem solving units.
- Students will work in small groups.
- In most of these units there is more than one answer.
- Units are student based and the lecturer adopts the role of facilitator rather than teacher.

The Description of the Units

For each of these five teaching units there is a tutor guide. In this section the title and the main objective(s) of each teaching unit will be outlined. The full descriptions of the units and tutor guides in both versions (Arabic and English) are in appendix (L). The units were taught in the same order. This order was chosen to move the student's thinking forward smoothly and gradually to change their perceptions of learning positively.

Unit one: Which Candidate is The Best

Students are asked to choose scientifically a suitable security guard from five candidates who have different height, weight and age.

At the end of this unit the student is expected to:

- Calculate the body mass index.
- Conclude from person body mass index his fitness.
- Appreciate that scientific evidence does not always lead to a clear-cut black and white answer.

Unit two: Special Frog

Students are asked three times to answer a question about the possible functions of the loose flaps of skin on the limbs of a specific kind of frog. Each time, they were provided with more information.

At the end of this unit the student is expected to:

- Have a brief idea about the flying frog.
- Realize that the knowledge derived from science may have to be changed if we find new information.

Unit three: Which dam?

Students are asked to select a position to built a dam from three possible positions. Each positions has some advantages and disadvantages.

At the end of the unit the student is expected to:

- Realize that in some scientific situations there is no one simple answer.

- Appreciate that there may be several factors which have to be considered in taking decisions in science.

Unit four: Is this really science?

In this unit an experiment about the negative effects of using mobiles phones was discussed. Furthermore, different opinions about this issue were discussed. Then students are asked to choose an opinion and justify it. Later they are asked to think about the nature of scientific knowledge.

At the end of this unit the student is expected to:

- Realise that knowledge derived from science is not always correct.
- Realise that knowledge derived from science is open to modification following further experimentation.
- Appreciate that the knowledge derived from science must be weighed carefully before decisions are taken.
- Realise that knowledge derived from science is constructed and is open to development.

Unit Five: Assessment Scheme Unit

Students are asked to design an assessment scheme for a teaching unit in an environmental education course.

At the end of this unit the student is expected to:

- Accept that there are many factors affecting some scientific decisions.
- Realize that in many cases to have effective assessment, the use of written tests may not be appropriate.
- Accept that students should be given the opportunity to show their own ideas in their assessment

7.4.3 Semi-structured interview

A semi-structured interview was developed in order to find out the experimental group students' opinions about the units they were experiencing.

Interviewing was used because it is one of the most important qualitative data collection instruments (Gay & Airasian, 2000; Fraenkel & Wallen, 2000). Furthermore, it is a very useful method to measure attitudes, perceptions or beliefs (Sax, 1979). In an interview, the respondent has the opportunity to ask for further information in greater depth, which will enrich the data (Borg, 1981; Sax, 1979; Thomas,1998).

After the researcher developed this interview it was pre-trialled with some students in the Centre of Science Education (University of Glasgow) in order to make sure that the questions were clear. Then the interview was translated to Arabic. The final version of the interview in its English and Arabic format is shown in appendix (M).

7.5 STUDY SAMPLE

In order to gain control of as many variables as possible, the application of the teaching units with all classes was undertaken by the researcher who followed procedures determined in advance. In fact, when the Colleges were approached informally, it was clear that the lecturers there were not confident about using the units. Second year students were selected because they were taking a course in methods of teaching science. The units fitted into this course appropriately. Because the researcher had to supervise all the groups undertaking the teaching units, it was decided to focus on only one college. However, only one college had large enough numbers to form sufficiently large control and experimental groups. This was an all-female college (note that females dominate the college intakes). Even with this selection, some 20 teaching occasions were supervised by the researcher. The total number of students involved was 318 divided into approximately two equal groups on a random basis. The 318 students were made up of 8 teaching groups and 4 were selected randomly as experimental group, 4 as control group.

7.6 STUDY PROCEDURES

- A letter was obtained from the Centre for Science Education (University of Glasgow) (see appendix N).
- A permission letter was obtained from the General Directorate of Education Colleges (Ministry of Higher Education) (see appendix O) then the experiment was carried out.

- After the second year groups were distributed to experimental and control groups, the pre-questionnaire was distributed to all groups.
- The teaching units were taught to the experimental group while the control group continued with their normal teaching. Later the post questionnaire was applied to both groups after three weeks of teaching of these units.

7.7 STATISTICAL TREATMENT OF THE DATA

The student's position for each question will be decided from her response to the questionnaire in the same way as used in the baseline measurement. The percentages of students in different positions were calculated for each question. The chi-square (χ^2) statistic will be used to test the significance of the difference between groups and between pre-questionnaire and post-questionnaire. The results will be presented graphically as well.

7.8 OPPORTUNITIES AND LIMITATIONS OF THE STUDY

Despite these limitations the experiment was carried out with a very reasonable number of students. Two groups were formed in order to gain an overall control of this experiment. The experiment went smoothly. The following limitations were recognised:

- *This study is applied in just one college.*
- *This study is applied in the basic education cycle one (going to teach age 6 to 10) programme.*
- *The researcher has a limited time to apply the teaching units (just three weeks).*
- *This part of the study was done with one year (year two) in the education colleges.*

The following chapter presents the data gathered and discusses its interpretation. The data are shown in full in appendix (P).

CHAPTER EIGHT

CHAPTER EIGHT
ANALYSIS OF FIELD EXPERIMENT

8.1 INTRODUCTION

In this chapter, the analysis of the field experiment will be discussed. The data from the pre-questionnaire and post-questionnaire for experimental and control groups will be summarised and analysed. The questions in the questionnaire will focus in four main areas:

- Lecturer's role.
- Student's role.
- The nature of scientific knowledge.
- Assessment.

Each area will be considered in turn and the questions which relate to that area will be discussed individually before drawing some more general conclusions. For each question, the data in five or six point scale will be grouped into 3 positions and a table will show the percentages of students who are in each position A to C under the adapted Perry scheme for pre-questionnaire and post-questionnaire for both groups. The table will also show the C/A ratio for each group in the pre-questionnaire and post questionnaire and the chi-square results of different comparison. The data will be summarized in graphical form. In the graph, the C/A ratio of students responses to the pre-questionnaire and post questionnaire will be shown for experimental group and control group.

In the discussion, the phrases 'perceptions of learning' and 'intellectual development' will be used interchangeably since, in the Johnstone adaptation of the Perry scheme, students' intellectual development is measured through their perceptions of learning.

Later in this chapter the interviews (see appendix M) which were carried to find out students opinions about the teaching units will be analysed.

It is extremely difficult to summarise the data in an accessible way. There are two sets of measurements (before and after) on the control group which reflect any changes which have happened to the population as a whole due to other teaching, other College experiences, and events around. There are also two sets of measurements (before and after) on the experimental group which reflect any changes which have happened to the population as a whole as well as any changes brought about by the teaching units.

The experimental and control groups were formed from groups already are existence in the colleges. The two groups turned out not to be identical in their responses (comparison of pre-tests for experiment and control groups).

For each question, the C/A ratio for each of these four measurements will be shown graphically along with a table showing four chi-square comparisons between measurements. The graphical presentation of the C/A ratio shows the general trend of change. However, because the C/A ratio ignores, to some extent, movements in and out of Perry B position, it is not a reliable indicator of movements. The chi-square value (and significance) is based on the *actual data for all positions* in the original measurement and it indicates whether movement is significant in statistical terms.

Thus, the most useful way to consider the data is to look at the pattern of C/A ratios but interpret this pattern in terms of statistical significance by considering the chi-square values.

8.2 LECTURER'S ROLE

Does the approach used in the teaching units develop the students' perceptions about the lecturer's role?

The questions related to perceptions of lecturer's role will be discussed. In all tables of comparison between different groups:

* *will be put near p-value when the chi-square is significant at the 5% level of probability.*

** *will be put near p-value when the chi-square is significant at 1% level of probability.*

Part A. Q 3. I believe it is the job of the lecturer to supply me with all the knowledge I need \ The duty of the lecturer is not to teach me everything, but to help me to think for myself

Table 8.1: comparison between different groups in Question 3 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	4.33	14.8	21.0	64.2	11.9	5	.036*
	Pre-con	5.32	14.4	9.1	76.5			
Comparison between	Pre-exp	4.33	14.8	21.0	64.2	5.0	5	.411
	Post-exp	6.80	9.3	26.9	63.8			
Comparison between	Pre-con	5.32	14.4	9.1	76.5	10.9	5	.054
	Post-con	5.10	13.8	15.8	70.4			
Comparison between	Post-exp	6.80	9.3	26.9	63.8	7.7	5	.173
	Post-con	5.10	13.8	15.8	70.4			

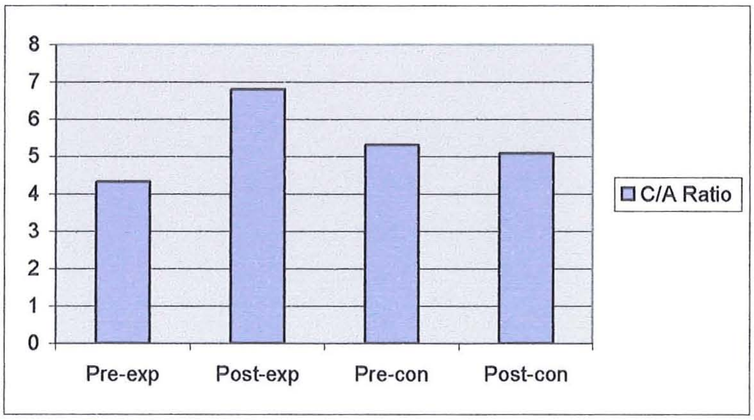


Figure 8.1: C/A Ratio for different groups in Question 3 part A

Figure 8.1 shows that the C/A ratio of the pre-questionnaire of the experimental group is lower than pre-questionnaire of the control group. The chi-square (χ^2) results show that the difference in students' responses in the underlying data is significant ($p = .036$).

Comparisons of pre-questionnaire and post-questionnaire outcomes for both groups are not significant. However, it is clear that the control group has become less disposed to C behaviour while the experimental group has become more disposed to C behaviour. This would suggest that the experimental group, from a lower starting position, has adopted more C type behavior.

Part A. Q4. I think teachers should avoid teaching materials that they know students will find difficult \ lecturer should aim to provide challenges to their students by introducing difficult topics.

Table 8.2: comparison between different groups in Question 4 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	1.87	23.6	32.3	44.1	14.1	5	.015*
	Pre-con	5.05	12.4	24.8	62.8			
Comparison between	Pre-exp	1.87	23.6	32.3	44.1	7.0	5	.220
	Post-exp	3.35	14.2	38.3	47.5			
Comparison between	Pre-con	5.05	12.4	24.8	62.8	15.5	5	.009**
	Post-con	3.08	16.4	32.9	50.7			
Comparison between	Post-exp	3.35	14.2	38.3	47.5	6.4	5	.267
	Post-con	3.08	16.4	32.9	50.7			

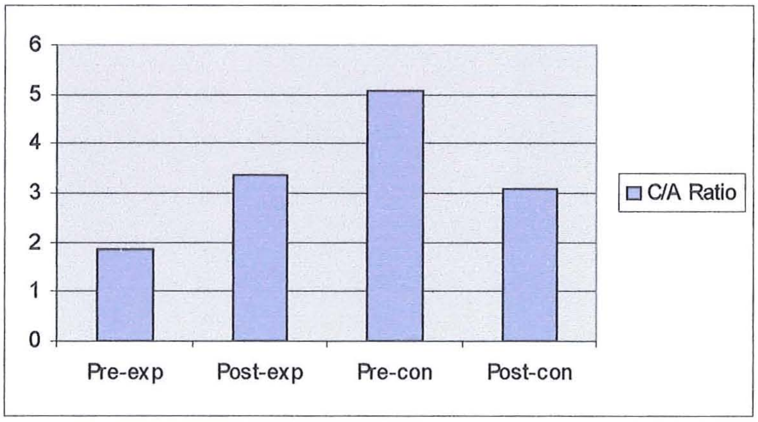


Figure 8.2: C/A Ratio for different groups in Question 4 part A

Figure 8.2 shows that the comparisons of the pre-questionnaire and post-questionnaire indicate that there is an increase in the C/A ratio in the experimental group while in control group there is a decrease. Chi-square results in table 8.2 show that the changes in the students' responses in the underlying data in the experimental group is not significant while in the control group is significant (P = .009).

In the pre-questionnaires, the control group was higher than the experimental group. The chi-square (χ^2) results show that the difference in students' responses in the underlying data is significant (P = .015) while there is no significant difference in post questionnaires. However, it is clear that the control group has become less disposed to C behaviour while the experimental group has become more disposed to C behaviour. This would suggest that the experimental group, from a lower starting position, has adopted more C type behaviour.

Part B Q 3. There is not any point in class teaching which includes things which will not be in the exam

Table 8.3: comparison between different groups in Question 3 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	3.51	20.4	7.4	71.6	8.2	4	.084
	Pre-con	2.56	24.8	15.0	60.1			
Comparison between	Pre-exp	3.51	20.4	7.4	71.6	5.5	4	.241
	Post-exp	3.72	18.0	14.9	67.1			
Comparison between	Pre-con	2.56	24.8	15.0	60.1	13.0	4	.011*
	Post-con	1.87	29.6	15.1	55.3			
Comparison between	Post-exp	3.72	18.0	14.9	67.1	10.6	4	.031*
	Post-con	1.87	29.6	15.1	55.3			

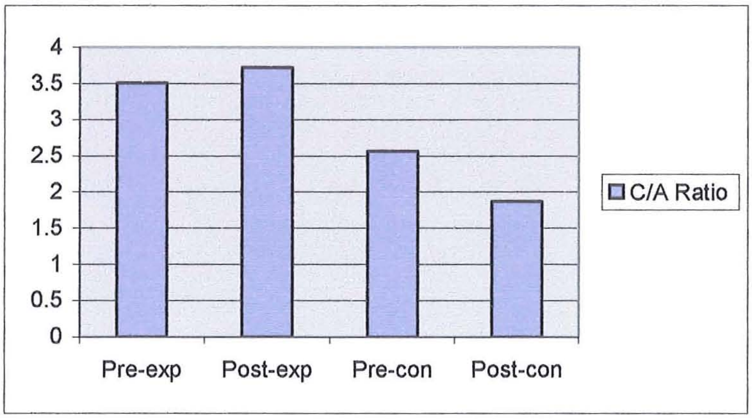
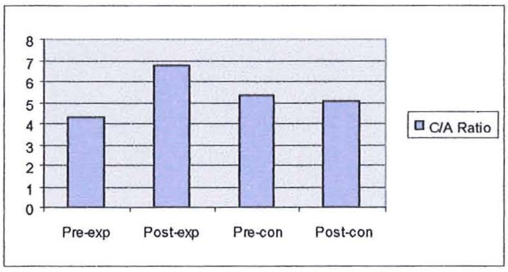


Figure 8.3: C/A Ratio for different groups in Question 3 part B

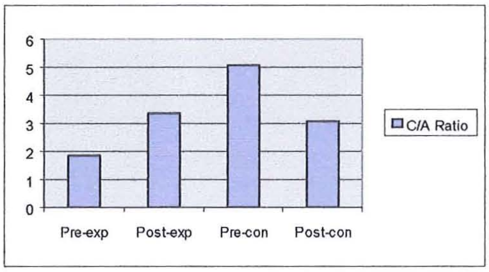
Figure 8.3 shows that there is an increase in the C/A ratio in the experimental group while in the control group there is a decrease. Chi-square results in table 8.3 show that the changes in the students' responses in the underlying data in the experimental group is not significant while in the control group is significant (p = .011).

There is no significance difference in the pre-questionnaires while, in post-questionnaires, the experimental group is significantly higher (p = .031). However, it is clear that the control group has become less intellectually developed while the experimental group has become more intellectually developed. This would suggest that the teaching units have enhanced the intellectual development of the experimental group.

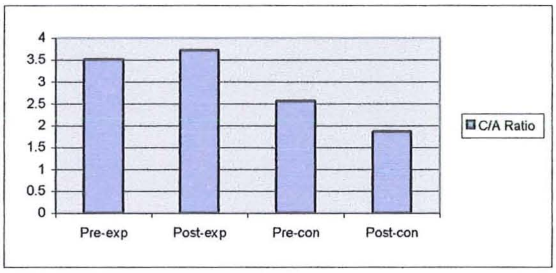
Summary



Question 3 part A



Question 4 part A



Question 3 part B

Figure 8.4: C/A ratio of questions related to students' perceptions about the lecturer's role

Figure 8.4 shows the pattern of C/A ratio for all three questions which are related to students' perceptions about the lecturer's role. Again, it has to be remembered that C/A ratio do not always reflect the pattern of response well in that the B position is not fully taken into account. It can be seen that, in all three questions, the C/A ratio increases with the experimental group while it is decreases with the control group. While the chi-square values do not suggest significance in all questions, the pattern in figure 8.4 does suggest that the teaching units may have helped the experimental group to develop their perceptions about the lecturer's role. It seems that the student based approach used in these teaching units made students realise that science could be learnt when the lecturer is working as a facilitator. In all these teaching units the lecturer's role were just to help students to learn by themselves. This shows them that science teaching can work effectively with the lecturer adopting a less central role.

8.3 STUDENT'S ROLE

Does the approach used in the teaching units develop the students' perceptions about the student's role?

Questions related to the perceptions of student's role will be discussed.

Part A. Q 1. In order to pass my courses, I need to study just what the lecturer tells me \ I do not have to rely totally on the lecturer. Part of my learning is to work things out myself

Table 8.4: comparison between different groups in Question 1 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	4.04	15.5	21.8	62.7	6.0	5	.31
	Pre-con	2.64	23.4	14.9	61.7			
Comparison between	Pre-exp	4.04	15.5	21.8	62.7	.45	5	.99
	Post-exp	3.81	16.1	22.8	61.1			
Comparison between	Pre-con	2.64	23.4	14.9	61.7	6.2	5	.29
	Post-con	3.93	17.6	13.1	69.3			
Comparison between	Post-exp	3.81	16.1	22.8	61.1	7.1	5	.22
	Post-con	3.93	17.6	13.1	69.3			

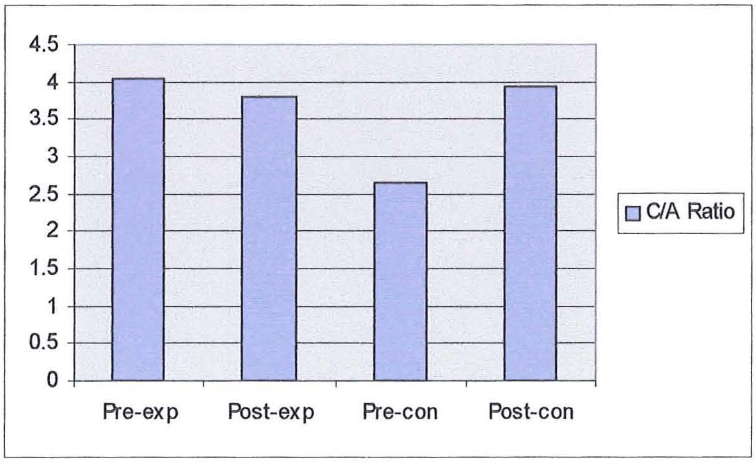


Figure 8.5: C/A Ratio for different groups in Question 1 part A

The figure 8.5 shows that there is a decrease in the C/A ratio in the experimental group while in control group there is an increase. However, chi-square results in table 8.4 show that both changes in the students' responses in the underlying data are not significant.

Comparisons of pre-questionnaire and post-questionnaire outcomes for both groups are not significant. This suggests that the teaching units have no effects on the students' perceptions as revealed by this question.

Part A. Q2. I cannot be wrong if I accept what the lecturer says. If I question anything, I might end up failing / I do not believe in just accepting what the lecturer says without question. Success involves thinking for myself

Table 8.5: comparison between different groups in Question 2 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	33	2.5	15.5	82.0	2.2	3	.54
	Pre-con	44	1.9	12.3	85.7			
Comparison between	Pre-exp	33	2.5	15.5	82.0	3.2	3	.37
	Post-exp	42	1.9	19.4	78.7			
Comparison between	Pre-con	44	1.9	12.3	85.7	3.1	3	.38
	Post-con	31.25	2.6	16.2	81.2			
Post-con	Pre-exp	42	1.9	19.4	78.7	1.4	3	.72
	Post-con	31.25	2.6	16.2	81.2			

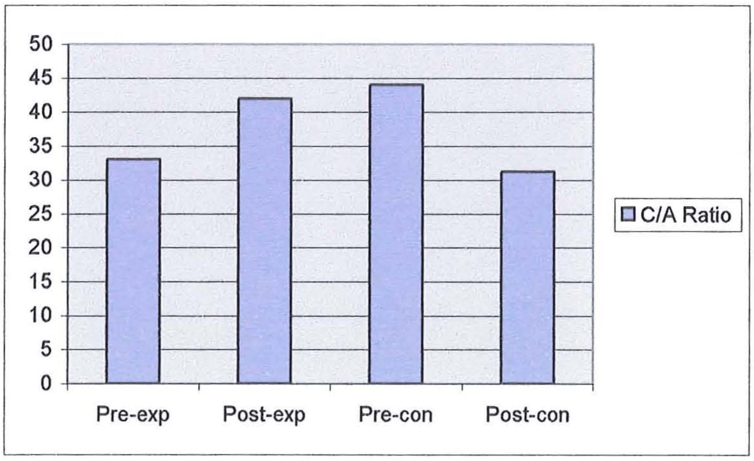


Figure 8.6: C/A Ratio for different groups in Question 2 part A

Figure 8.6 shows that the C/A ratio of the pre-questionnaire of the experimental group is lower than pre-questionnaire of the control group. However, chi-square (χ^2) results in table 8.5 show that the difference in the students' responses in the underlying data is not significant.

Comparisons of pre-questionnaire and post-questionnaire outcomes for both groups are not significant. However, it is clear that the experimental group has become more intellectually developed while the control group has become less intellectually developed. This would suggest it may be that the teaching units have enhanced the intellectual development of experimental group.

Part A. Q 5. It is good to work with other students because, by listening to their points of view, I can correct my ideas \ I prefer not to work with other students because then I stand less chance of picking up wrong ideas

Table 8.6: comparison between different groups in Question 5 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	15.2	5.6	9.3	85.1	6.4	3	.09
	Pre-con	35.8	2.6	4.5	92.9			
Comparison between	Pre-exp	15.2	5.6	9.3	85.1	4.8	3	.19
	Post-exp	35.0	2.5	11.1	86.4			
Comparison between	Pre-con	35.8	2.6	4.5	92.9	5.0	3	.17
	Post-con	18.7	4.6	9.8	85.6			
Comparison between	Post-exp	35.0	2.5	11.1	86.4	1.0	3	.80
	Post-con	18.7	4.6	9.8	85.6			

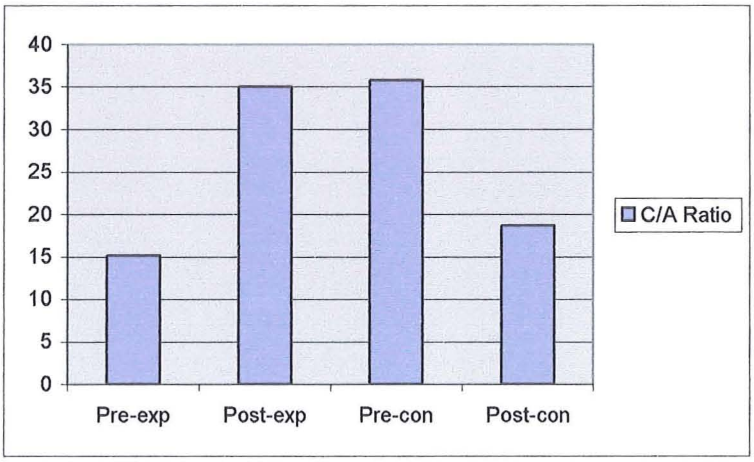


Figure 8.7: C/A Ratio for different groups in Question 5 part A

Figure 8.7 shows that there is an increase in the C/A ratio of the experimental group and a decrease in the control group. The chi-square (χ^2) results show that these changes in the students' responses in the underlying data are not significant.

Comparisons of pre-questionnaire and post-questionnaire outcomes for both groups are not significant. However, it is clear that the control group has become less disposed to C behaviour while the experimental group has become more disposed to C behaviour. This would suggest it may be that the experimental group, from a lower starting position, has adopted more C type behaviour.

Part B. Q 2. Sometimes I find I learn more about a subject by discussing it with other students than I do by sitting and revising at home

Table 8.7: comparison between different groups in Question 2 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	4.65	16.0	9.3	74.7	4.45	3	.22
	Pre-con	3.43	19.5	13.6	66.9			
Comparison between	Pre-exp	4.65	16.0	9.3	74.7	3.8	3	.28
	Post-exp	8.73	9.2	9.9	80.9			
Comparison between	Pre-con	3.43	19.5	13.6	66.9	5.3	3	.15
	Post-con	6.94	10.5	17.0	72.5			
Comparison between	Post-exp	8.73	9.2	9.9	80.9	3.9	3	.27
	Post-con	6.94	10.5	17.0	72.5			

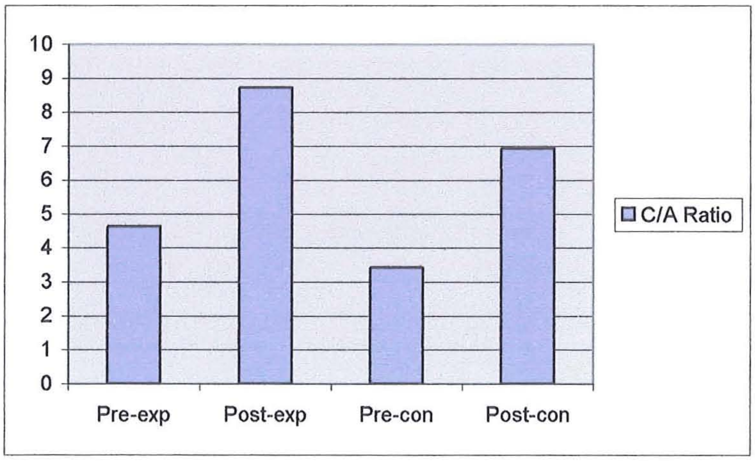


Figure 8.8: C/A Ratio for different groups in Question 2 part B

Figure 8.8 shows that there are increases in the C/A ratio in both groups. The increases look very large but the chi-square (χ^2) results show that the difference in the students' responses in the underlying data is not significant. This is because the chi-square take in account all the data while the C/A ratio can change markedly with small changes in percentages in A and in C.

Comparisons of pre-questionnaires and post-questionnaire outcomes for both groups are not significant. However, it is clear that both groups become more disposed to C behavior although the χ^2 values are not significant. This would suggest that the changes here are related to outside factors.

Part B. Q6. I feel uncomfortable when I am left to express an opinion, not knowing the view the lecturer feels

Table 8.8: comparison between different groups in Question 6 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison	Pre-exp	2.64	22.8	17.1	60.1	6.2	4	.52
between	Pre-con	1.52	30.5	23.2	46.4			
Comparison	Pre-exp	2.64	22.8	17.1	60.1	3.1	4	.55
between	Post-exp	2.00	28.0	15.9	56.1			
Comparison	Pre-con	1.52	30.5	23.2	46.4	1.1	4	.89
between	Post-con	1.97	26.0	22.7	51.3			
Comparison	Post-exp	2.00	28.0	15.9	56.1	2.5	4	.64
between	Post-con	1.97	26.0	22.7	51.3			

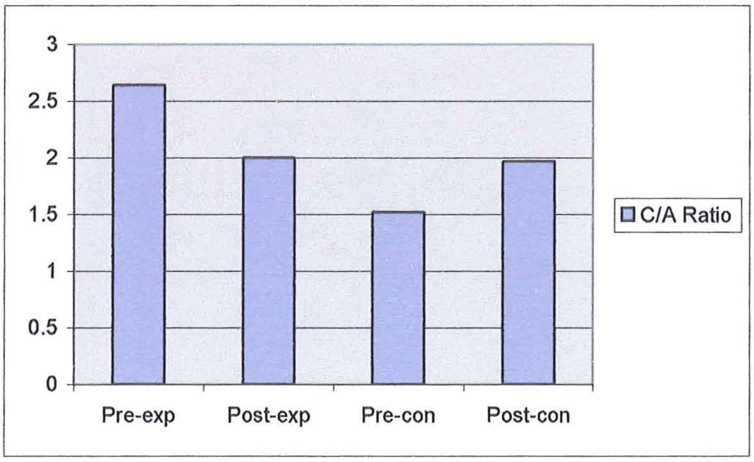
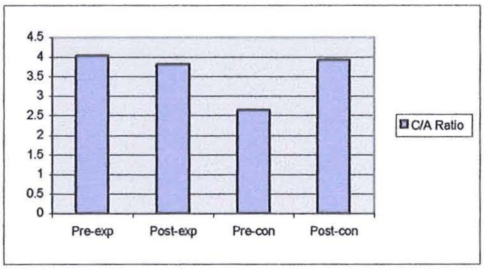


Figure 8.9: C/A Ratio for different groups in Question 6 part B

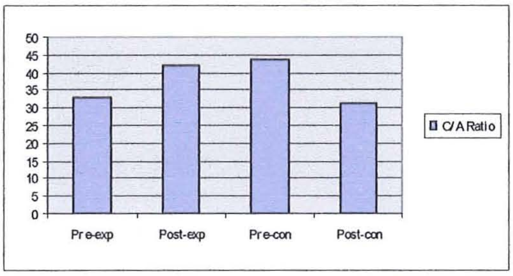
The figure 8.9 shows that there is a decrease in the C/A ratio in the experimental group and an increase in the control group. However, chi-square (χ^2) results show that the differences in the students' responses in the underlying data are not significant.

In pre-questionnaires and in the post-questionnaires there were no significance differences between both groups. This suggests that the teaching units have no effects on the students' perceptions about this question.

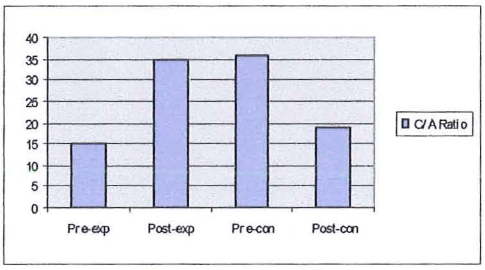
Summary



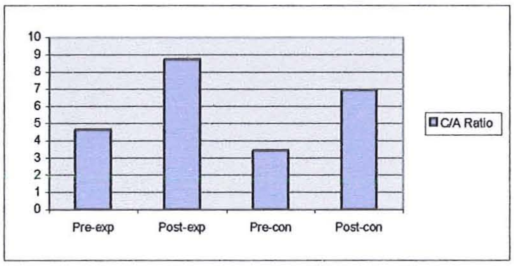
Question 1 part A



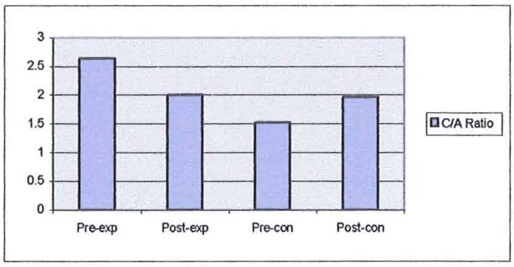
Question 2 part A



Question 5 part A



Question 2 part B



Question 6 part B

Figure 8.10: C/A ratio of questions related to students' perceptions about the student's role

Looking at figure 8.10, there is no obvious pattern between the five sets of C/A ratios. This may reflect the fact that the role of students was not one of the aims of the units. The observed results may reflect other factors rather than the units. For example, in question 2 part B, the increases in the C/A ratio with both experimental and control groups suggests some outside factors. However, in all questions related to students' role all changes are not significant. This may suggest that the students perceptions of the student's role were not altered by the teaching units.

8.4 THE NATURE OF SCIENTIFIC KNOWLEDGE

Does the approach used in the teaching units develop the students' perceptions about the nature of scientific knowledge?

Questions related to students' perceptions of the nature of scientific knowledge will be discussed.

Part A. Q6. All one has to do in science is to memorise things \ Understanding science is the key part of science study

Table 8.9: comparison between different groups in Question 6 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	50	1.9	4.4	93.7	1.1	2	.56
	Pre-con	48	2.0	3.9	94.1			
Comparison between	Pre-exp	50	1.9	4.4	93.7	1.1	2	.57
	Post-exp	147	0.6	7.5	91.9			
Comparison between	Pre-con	48	2.0	3.9	94.1	1.3	2	.51
	Post-con	70.50	1.3	6.5	92.2			
Comparison between	Post-exp	147	0.6	7.5	91.9	1.4	2	.50
	Post-con	70.50	1.3	6.5	92.2			

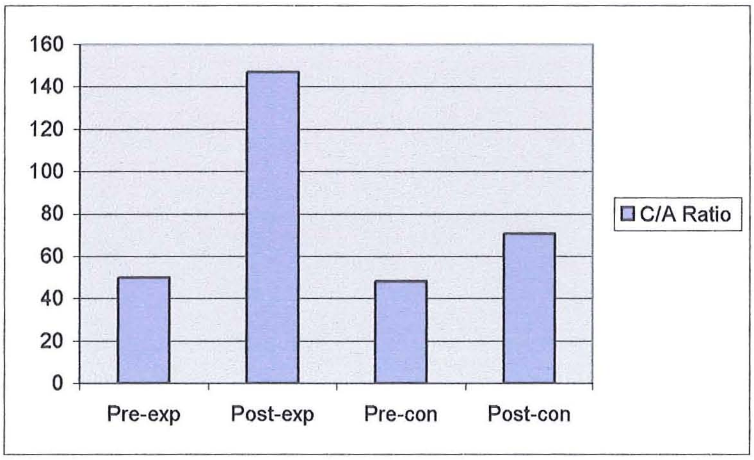


Figure 8.11: C/A Ratio for different groups in Question 6 part A

Figure 8.11 shows that there are increases in the C/A ratio of both groups, but the chi-square (χ^2) results show that the differences in the students' responses in the underlying data are not significant.

Table 8.9 shows that the outcomes of pre-questionnaires and post-questionnaires for both groups are not significant. However, it is clear that both groups become more disposed to C behaviour. This would suggest that the changes here may be related to outside factors.

However, a deep looking at students' percentages at C position suggests that the percentages of students in this position were very high from the beginning for all groups which make any significant change very difficult.

Part A Q7. I do not believe that all scientific knowledge represents the 'absolute truth' / We cannot call anything scientific knowledge if it is not absolutely true

Table 8.10: comparison between different groups in Question 7 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	1.80	29.3	17.8	52.9	12.6	5	.03*
	Pre-con	1.29	32.9	24.8	42.3			
Comparison between	Pre-exp	1.80	29.3	17.8	52.9	30.7	5	.00**
	Post-exp	5.81	13.6	11.7	75.3			
Comparison between	Pre-con	1.29	32.9	24.8	42.3	5.0	5	.42
	Post-con	1.43	30.3	26.3	43.4			
Comparison between	Post-exp	5.81	13.6	11.7	75.3	57.4	5	.00**
	Post-con	1.43	30.3	26.3	43.4			

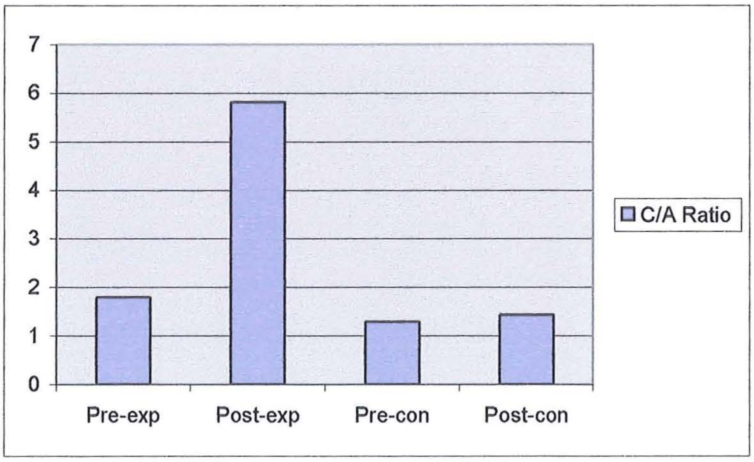


Figure 8.12: C/A Ratio for different groups in Question 7 part A

Figure 8.7 shows that there are increases in the C/A ratio of both groups. The chi-square (χ^2) results in table 8.10 show that the difference in the students' responses in the underlying data of experimental group is significant (p = .00).

In the pre-questionnaire the C/A ratio of experimental group is higher than control group. The chi-square (χ^2) results show that the difference in the students' responses in the underlying data is significant (p =.03). In the post-questionnaire the experimental group is still higher. The chi-square (χ^2) results show that the difference in the students' responses in the underlying data is significant (p = .00). However, it is clear that the experimental group has become more disposed to C behaviour. This would suggest strongly that the experimental group, from a low starting position, has adopted more C type behavior. This suggests that there is very clear evidence that the positive improvement in students' perceptions of learning is related to the teaching units.

Part B. Q1. Sometimes there seem to be so many ways of looking at science that I feel confused about what is right and wrong

Table 8.11: comparison between different groups in Question 1 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	0.13	72.8	17.9	9.3	5.3	3	.15
	Pre-con	0.16	69.9	19.0	11.1			
Comparison between	Pre-exp	0.13	72.8	17.9	9.3	6.7	3	.08
	Post-exp	0.10	83.3	8.7	8.0			
Comparison between	Pre-con	0.16	69.9	19.0	11.1	4.0	3	.26
	Post-con	0.07	75.3	19.5	5.2			
Comparison between	Post-exp	0.10	83.3	8.7	8.0	12.7	3	.01**
	Post-con	0.07	75.3	19.5	5.2			

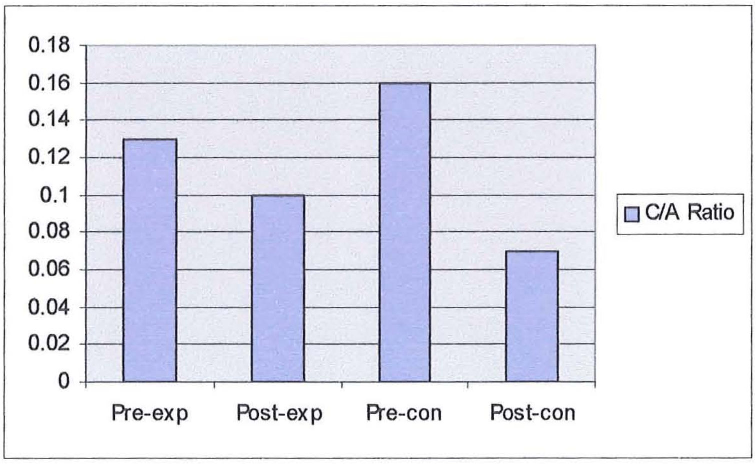


Figure 8.13: C/A Ratio for different groups in Question 1 part B

Figure 8.13 shows that there are decreases in the C/A ratio of both groups. The chi-square (χ^2) results in table 8.10 show that these changes in the students' responses in the underlying data are not significant.

In the post questionnaire the C/A ratio of the experimental group is higher. The chi-square (χ^2) results in table 8.10 show that this change in the students' responses in the underlying data is significant (p = .01) while in the pre-questionnaire there is no significant difference. This may lead to suggest that although the teaching units do not improve the students' intellectual development but they helped experimental group students to maintain better intellectual development than the control group students do. This would suggest that the teaching units have positive effects on the intellectual development of the experimental group although they did not increase the C/A ratio.

Part B. Q5. It is a waste of time to work on problems which have no possibility of producing a clear-cut, unambiguous answer

Table 8.12: comparison between different groups in Question 5 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	1.67	30.8	17.6	51.6	3.2	4	.52
	Pre-con	1.21	38.2	15.8	46.0			
Comparison between	Pre-exp	1.67	30.8	17.6	51.6	3.9	4	.42
	Post-exp	2.16	23.8	25	51.2			
Comparison between	Pre-con	1.21	38.2	15.8	46.0	11.3	4	.02*
	Post-con	1.28	35.3	19.6	45.1			
Comparison between	Post-exp	2.16	23.8	25	51.2	7.3	4	.12
	Post-con	1.28	35.3	19.6	46.0			

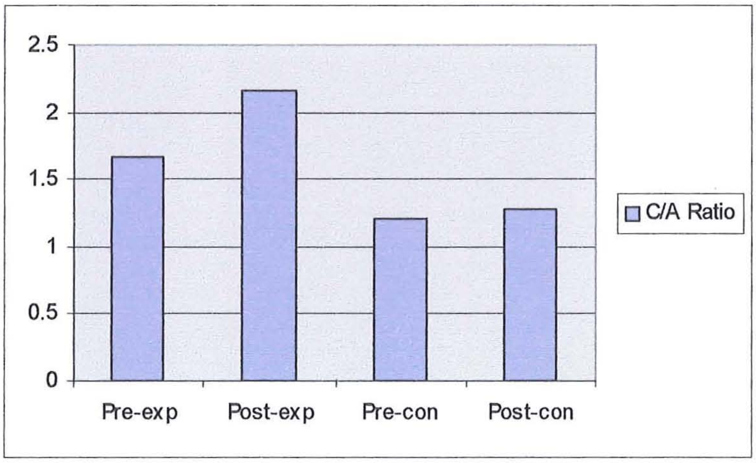


Figure 8.14: C/A Ratio for different groups in Question 5 part B

Figure 8.1 shows that there are increases in the C/A ratio of both groups. However, the chi-square results in table 8.12 show that the change in the students' responses in the underlying data in the experimental group is not significant but the change in the control group is significant (p = .02).

Table 8.12 shows that, in the pre-questionnaires, there is no significance difference between experimental and control groups. The same is true in the post-questionnaires. However, it is clear that the control group has become significantly more intellectually developed. Table 8.12 shows that the change are mainly from A position to B position in both groups. This would suggest that the changes here are related to outside factors, assuming the units did not produce any negative effect.

Part B. Q 7. A good thing about learning science is the fact that everything is so clear-cut: either right or wrong

Table 8.13: comparison between different groups in Question 7 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	1.05	35.2	27.8	37.0	6.0	4	.20
	Pre-con	0.83	39.5	27.6	32.9			
Comparison between	Pre-exp	1.05	35.2	27.8	37.0	15.5	4	.00**
	Post-exp	2.17	26.1	17.4	56.5			
Comparison between	Pre-con	0.83	39.5	27.6	32.9	3.1	4	.54
	Post-con	1.02	33.1	33.1	33.8			
Comparison between	Post-exp	2.17	26.1	17.4	56.5	28.4	4	.00**
	Post-con	1.02	33.1	33.1	33.8			

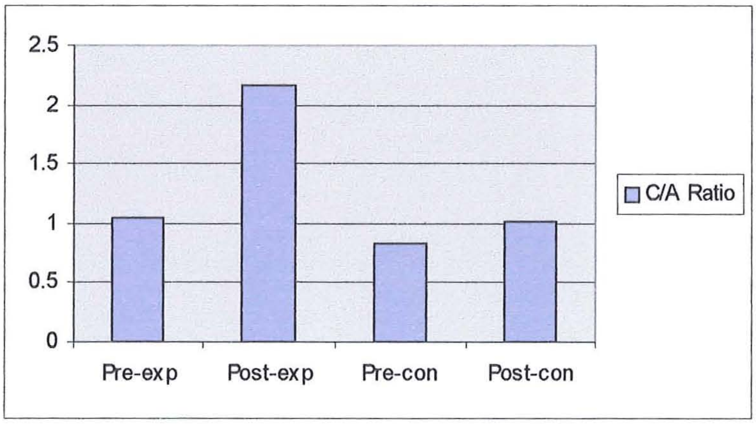
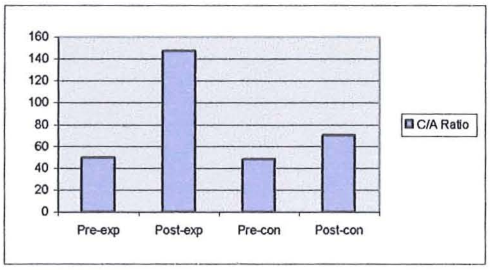


Figure 8.15: C/A Ratio for different groups in Question 7 part B

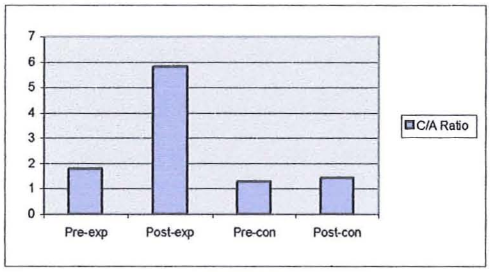
Figure 8.15 shows that there are increases in the C/A ratio of both groups. Chi-square (χ^2) results in table 8.13 show that the change in the students' responses in the underlying data in the experimental group is significant (p = .00) while in the control group is not significant.

Table 8.13 shows that in the pre-questionnaires there is no significant difference between experimental and control groups. In the post-questionnaires, the C/A ratio of the experimental group is higher than the control group. Chi-square (χ^2) results in table 8.13 show that the change in the students' responses in the underlying data is significant (p = .00). However, it is clear that the experimental group has become significantly more disposed to C behaviour. This would suggest strongly that the experimental group, from a low starting position, has adopted more C type behaviour. It is clear also that the percentages of students at C position increase dramatically from 37.0% to 56.5% in the experimental group. The positive changes here have clearly resulted from the teaching units.

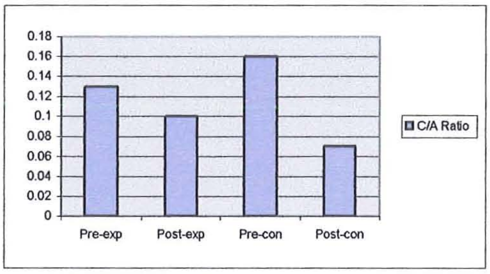
Summary



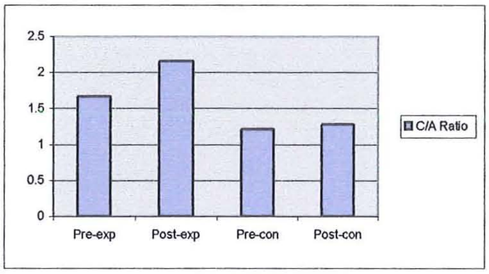
Question 6 part A



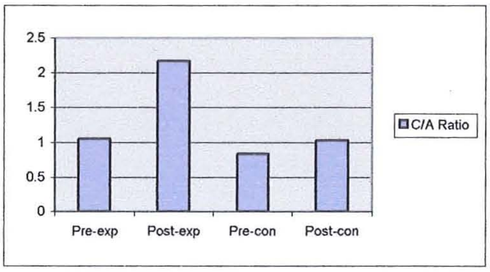
Question 7 part A



Question 1 part B



Question 5 part B



Question 7 part B

Figure 8.16: C/A ratio of questions related to students' perceptions about the nature of scientific knowledge

Looking at figure 8.16, there is an obvious pattern between four of five sets of C/A ratios. In four of the five questions, the experimental groups shows a marked increase in the ratios while the control group show almost no change. In the fifth question (question 1 part B) the control group shows a very large drop (suggesting some external factors) while the experimental group shows a much smaller drop. Generally the results showed dramatic increases in the percentages of students in C position for the experimental group.

All evidence in this area suggest strongly that the teaching units have very positive effects in the students' perceptions of the nature of scientific knowledge. However, it worth to keep in mind, that improving students' perceptions of the nature of scientific knowledge was a main aim for these units.

8.5 ASSESSMENT

Does the approach used in the teaching units develop the students' perceptions about the assessment?

Questions related to students' perceptions of assessment will be discussed.

Part A. Q8. I do not like short questions as they do not give me the chance to explain what I know and understand / I prefer to learn the facts and then be tested on them in short questions

Table 8.14: comparison between different groups in Question 8 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	0.64	44.4	27.2	28.4	3.1	5	.69
	Pre-con	0.71	42.8	27.0	30.2			
Comparison between	Pre-exp	0.64	44.4	27.2	28.4	9.7	5	.08
	Post-exp	1.04	33.1	32.5	34.4			
Comparison between	Pre-con	0.71	42.8	27.0	30.2	4.3	5	.51
	Post-con	0.57	45.0	29.1	25.8			
Comparison between	Post-exp	1.04	33.1	32.5	34.4	6.5	5	.26
	Post-con	0.57	45.0	29.1	25.8			

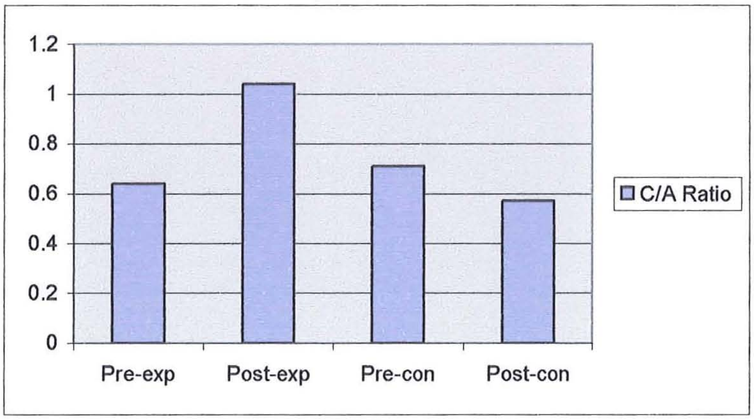


Figure 8.17: C/A Ratio for different groups in Question 8 part A

Figure 8.17 shows that there is an increase in the C/A ratio of the experimental group while in the control group there is a decrease. However, the chi-square (χ^2) results in table 8.14 show that the differences in the students' responses in the underlying data are not significant.

Table 8.14 shows that there is no significant difference between groups in the pre-questionnaires nor in the post questionnaires. However, it is clear that the control group has become less disposed to C behaviour while the experimental group has become more disposed to C behaviour. This would suggest that the experimental group, from a lower starting position, has adopted more C type behavior.

Part A. Q9. In exams I prefer questions which are based on what the lecturer taught / In exams, I like questions that give me the scope to go beyond what is taught and show my ability to think

Table 8.15: comparison between different groups in Question 9 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	0.39	50.0	30.2	19.8	9.7	5	0.08
	Pre-con	0.71	44.8	23.4	31.8			
Comparison between	Pre-exp	0.39	50.0	30.2	19.8	8.2	5	.15
	Post-exp	0.75	34.6	39.5	25.9			
Comparison between	Pre-con	0.71	44.8	23.4	31.8	5.6	5	.35
	Post-con	0.56	43.4	32.2	24.4			
Comparison between	Post-exp	0.75	34.6	39.5	25.9	5.6	5	.35
	Post-con	0.56	43.4	32.2	24.4			

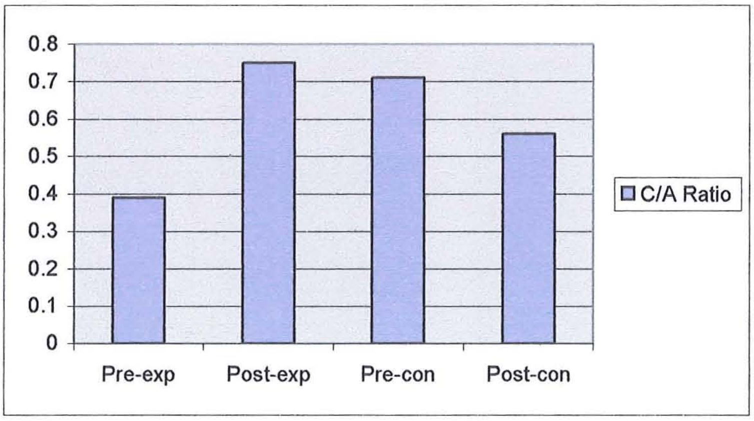


Figure 8.18: C/A Ratio for different groups in Question 9 part A

Figure 8.18 shows that there is an increase in the C/A ratio of the experimental group while in the control group there is a decrease. However, the chi-square (χ^2) results show that the changes in the students' responses in the underlying data are not significant.

Table 8.14 shows that there is no significant difference between groups in the pre-questionnaires or in the post questionnaires. However, it is clear that the control group has become less disposed to C behavior while the experimental group has become more disposed to C behaviour. This would suggest that the experimental group, from a lower starting position, has adopted more C type behaviour.

Part A. Q10. I believe that what should matter in exams is the quality of my answers, not how much I write \ In exams, I expect to be rewarded for giving as much information as possible

Table 8.16: comparison between different groups in Question 10 part A

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	17	4.9	11.1	84.0	9.9	5	.08
	Pre-con	5.81	13.6	7.2	79.2			
Comparison between	Pre-exp	17	4.9	11.1	84.0	6.9	4	.14
	Post-exp	15.56	5.6	8.0	86.4			
Comparison between	Pre-con	5.81	13.6	7.2	79.2	6.4	5	.27
	Post-con	8.57	9.1	13.0	77.9			
Comparison between	Post-exp	15.56	5.6	8.0	86.4	6.2	5	.29
	Post-con	8.57	9.1	13.0	77.9			

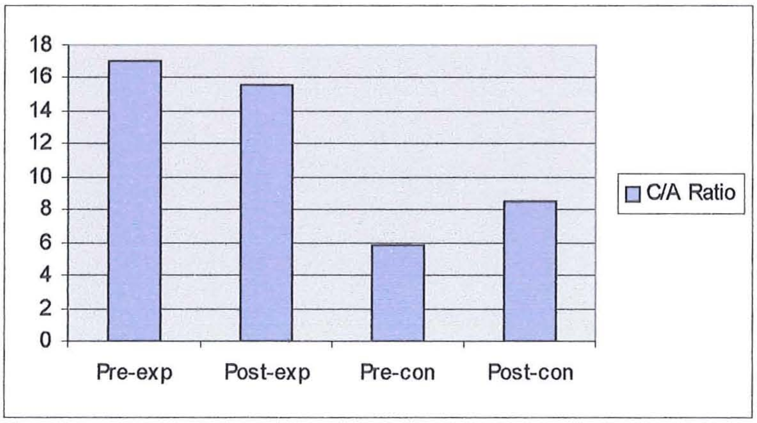


Figure 8.19: C/A Ratio for different groups in Question 10 part A

Figure 8.19 shows that there is a decrease in the C/A ratio of the experimental group while in the control group there is an increase. However, the chi-square (χ^2) results show that the changes in the students' responses in the underlying data are not significant.

Table 8.16 shows that there is no significant difference between groups in the pre-questionnaires nor in the post questionnaires. This suggests that, in this question, teaching units have no effects on the students intellectual development. By looking at the percentages of students in the position C in the pre-questionnaire it is clear that the percentages are very high which made any increase in the C percentages very difficult.

Part B. Q4. If I have the choice of written comments or a specific mark at the end of a piece of science coursework, I would choose the comments

Table 8.17: comparison between different groups in Question 4 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	12.4	6.2	16.8	77.0	8.3	3	.04*
	Pre-con	4.91	14.4	15.0	70.6			
Comparison between	Pre-exp	12.4	6.2	16.8	77.0	.11	3	.99
	Post-exp	13.78	5.6	16.9	77.5			
Comparison between	Pre-con	4.91	14.4	15.0	70.6	5.9	3	.12
	Post-con	4.89	12.5	26.3	61.2			
Comparison between	Post-exp	13.78	5.6	16.9	77.5	11.9	3	.01**
	Post-con	4.89	12.5	26.3	61.2			

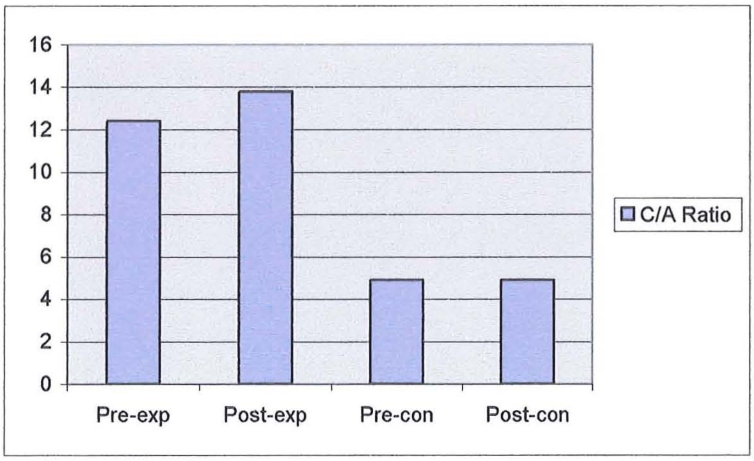


Figure 8.20: C/A Ratio for different groups in Question 4 part B

Figure 8.20 shows that there is an increase in the C/A ratio of the experimental group while in the control group there is a decrease. However, the chi-square (χ^2) results in table 8.17 show that neither of these changes in the students' responses in the underlying data is significant.

Table 8.17 shows that, in the pre-questionnaires, the C/A ratio of the experimental group is higher. The difference in the students' responses in the underlying data is significant ($p = .04$). In the post-questionnaires, the experimental group still has higher C/A ratio. The change in the students' responses in the underlying data is significant ($p = .01$). However, it is clear that the control group has become less disposed to C behaviour while the experimental group has become more disposed to C behaviour. This would suggest strongly that the experimental group has adopted more C type behaviour.

Part B. Q8. I like exams which give me an opportunity to show I have ideas of my own

Table 8.18: comparison between different groups in Question 8 part B

		C/A Ratio	% of students			χ^2	d.f.	P value
			A	B	C			
Comparison between	Pre-exp	14.2	6.2	6.2	87.7	1.0	3	.80
	Pre-con	11.0	7.8	6.5	85.7			
Comparison between	Pre-exp	14.2	6.2	6.2	87.7	1.9	3	.60
	Post-exp	10.9	8.0	4.9	87.0			
Comparison between	Pre-con	11.0	7.8	6.5	85.7	5.4	3	.14
	Post-con	16.5	5.2	9.1	85.7			
Comparison between	Post-exp	10.9	8.0	4.9	87.0	6.0	3	.11
	Post-con	16.5	5.2	9.1	85.7			

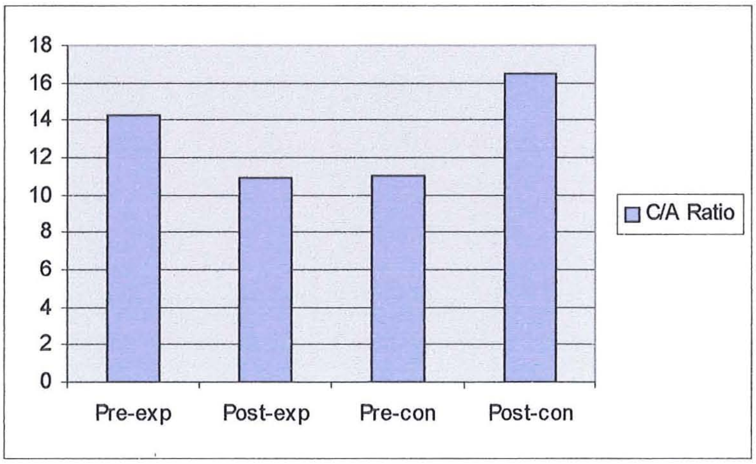
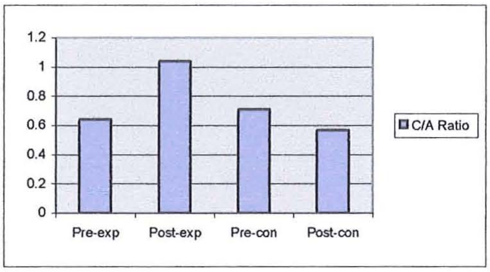


Figure 8.21: C/A Ratio for different groups in Question 8 part B

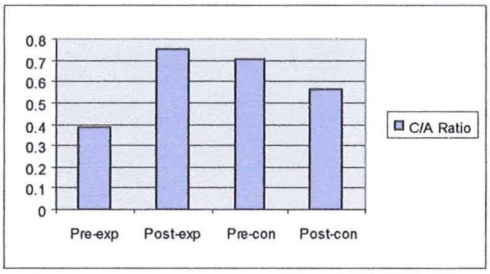
The figure 8.21 shows that there is a decrease in the experimental group while in the control group there is an increase. The chi-square (χ^2) results in table 8.18 show that none of these changes in the students' responses in the underlying data is significant.

Table 8.18 shows that, in the pre-questionnaires, there is no significant difference between experimental and control groups. In the post-questionnaires there is no significant difference between experimental and control groups. This suggests that, in this question, the teaching units have no effects on intellectual development. However, by looking at the percentages in the C position, it is clear that the percentages of students at C position are high from the pre-questionnaire, which made any increase in the percentage of C very difficult. The changes here are between position A and B position

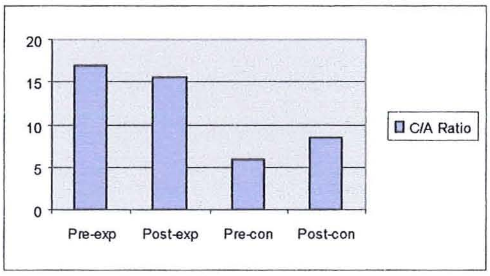
Summary



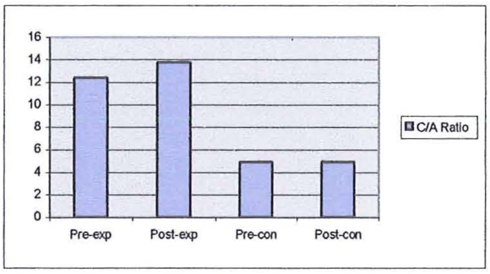
Question 8 part A



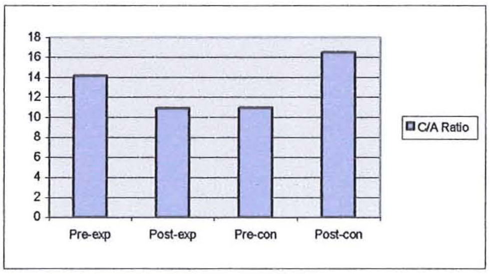
Question 9 part A



Question 10 part A



Question 4 part B



Question 8 part B

Figure 8.22: C/A ratio of questions related to students' perceptions about the assessment

The results indicate that it seems that in general the teaching units may have positive effects in the students' perceptions of the assessment although there is no general pattern in all 5 questions. As shown in figure 8.22, in 3 out of 5 questions (questions 8 part A, 9 part A and 4 part B) the C/A ratio of the experimental group increase while the C/A ratio of the control group decreases. This suggests that in these questions the teaching units seems to have positive effects on students' perceptions. On the other two questions there are no effects on students' perceptions. However, in these two questions the percentages of students in C position are very high in the pre-questionnaire, which made any significant increase very difficult. However, by considering the fact that only one of five teaching units used was aimed to promote students perceptions about assessment, the positive changes noticed in the experimental group seems to be strongly encouraging. All other units were concentrated on changing students' perceptions about the nature of scientific knowledge. This result may suggest that it is very useful to let our students think about the assessment to promote their perceptions of assessment.

Summary of Summaries

Initially the teaching units used in this part of the study were mainly aimed to enhance students perceptions of the nature of scientific knowledge and partially enhancing students' perceptions of assessment. The results showed that there is a very significant improvement in students in the perceptions of the nature of scientific knowledge. Furthermore there is a positive improvement in their perceptions of assessment and lecturer's role. The results also revealed that generally there was not much improvement the students' perceptions of student's role. However that was not an aim from the beginning. This part of the study was aimed to change students' perceptions in two areas and ended by changing three areas, which is a very encouraging result. In the following section, students' interview will be analysed to find out students' opinions about these teaching units to see if there is any corroboration of these findings.

8.6 STUDENTS' INTERVIEWS

A semi-structured interview was carried out with 51 students who participated in the experimental group. The interviews took place after the experiment was finished in order to explore their opinions about these teaching units. The interviews were short (around 15 minutes) and conducted by the researcher with all these students. In the interviews a question was asked and then the student was allowed to talk freely, with occasional promptings. The researcher tried not to interrupt unless the students asked for clarification. In this section, the results of this interview will be analysed and discussed. Each question will be discussed alone.

Q1. What do you like most in these teaching units? (if any)

The results of this question show that there was a general satisfaction with the teaching units used in the experiment. All students drew attention to a wide range of aspects which they like. These thing are summarised using their words but translated into English:

- *The new information which was very helpful.*
- *These units show that the scientific knowledge is not black or white or absolutely true.*
- *The gradual presentation of the units which drive students smoothly and logically through the units such as putting the units in different parts.*
- *Given the students the opportunity to express their own ideas about the issues tackled in these units.*
- *Related the issues used in these units to students environment and everyday life which make these issues more interesting.*
- *These units encourage students to discover and to find more about the issues used in these issues.*
- *These units correct some information I had.*
- *These units show that in order to make good scientific judgment all information related to the judgment should be known.*
- *The units helped us to apply what we had learnt in our life.*
- *These units encourage high cognitive skills (analysis, synthesis and evaluation) and some students think that these units encourage all cognitive skills.*
- *The use of cooperative learning to conduct these units which help students to benefit from the other students ideas. Units encourage students to be active learners.*
- *Encourage the scientific thinking by making students analyse and interpret the given information.*
- *Usefulness of these units.*
- *The well-designed nature of these units.*
- *These units were very interesting.*

- *The high amount of information which was very organized and which went from the easy to the difficult, very easy and very smooth.*
- *These units were student based.*
- *The consideration and respect given to students ideas.*
- *These units show us the importance of scientific research.*
- *Introduced these units as problems which help students to develop their scientific thinking.*
- *Increase my belief that scientific knowledge could be modified or improved.*
- *These units do not make students bored like the ordinary lecture.*
- *Help us to keep the scientific knowledge for long time.*
- *The questions used were attracting students' attention because they were very clever and will formed and they encourage the scientific thinking.*
- *The units have no marks which give the students the opportunity to think freely.*
- *These units were not based on memorising.*
- *These units represent new teaching methods.*
- *Develop the cooperative values among students.*
- *These units discussed the characteristics of science.*
- *Encourage students to think about some environmental problems.*
- *Teach students some good teaching methods which can be used in teaching science.*
- *Teaching students to criticise the scientific knowledge before accepting it.*

Moreover, many students mentioned the teaching units they liked most. All units were mentioned but 'which candidate is the best' unit and 'special frog' unit were the units most mentioned by students.

The things that students like about these units can be divided into two main areas the style of teaching and the things they think that these units can help students to develop. The style area includes many things such as the setting of these units as problem solving, student based, given the students the opportunity to show their own ideas. They also like the questions style which they think is very clever and represent the high order cognitive skills (analysis, synthesis and evaluation).

The second area includes many things such as that these units help students to develop the scientific thinking, develop all cognitive skills especially high order cognitive skills and develop students perceptions about the nature of scientific knowledge.

The idea of relating these units to students' life and students environment seems to fascinate students and they seem to like it very much. This is because that they think that this made the units more interesting and more useful.

Clearly, the units were found to be attractive to the students and there is some conformation that their perceptions of the nature of scientific knowledge were developed.

Q2. What do you dislike in these teaching units? (if any)

The vast majority of students said that they liked all aspects of the teaching units, with only 13 out of 51 thinking that they did not like that some questions in these units seem to have more than one possible answer. At the same time, all those 13 students mentioned that immediately after the fact that they like these units very much. One student also mentioned that this is maybe because she always used to get one right answer through the long study of science and because of that it seems for her that it is impossible to have more than one right answer in science.

One student, for example, said that in the "is this really science" unit she cannot conclude one right answer and it seems for her impossible to make just one right answer. Different students also gave different examples. However, this was one of the main aims of these units, to put students in a position where there could be more than one answer in order to help them to develop their perceptions about the nature of scientific knowledge. The dislike of that by some students is understandable because by putting them in such situations, their beliefs about the nature of scientific knowledge are challenged. This may make them feel uncertain and uncomfortable. However, those who think that, are just a small number. This observation is very like the concept of dissonance which is often observed in attitude change situations

(Festinger, 1957). Again, this offers some support that students' perceptions have been changed.

3. Do you think that it is useful to have units like these in schools? Why?

In this question 50 out of 51 said 'yes' and they gave different reasons for their decisions. This can be summarised into the following points:

- To replace the boring units available at schools which do not prepare students for their future.
- These units increase students' scientific knowledge.
- These units encourage all cognitive skills especially the high order cognitive skills (analysis, synthesis, evaluation).
- These units enhance scientific thinking.
- These units give students the opportunity to show their own ideas.
- The information in these units is well presented and they go gradually into students' mind.
- Open new horizons for the students.
- Train students to accept different opinions.
- Enhance students attitudes about the scientific knowledge.
- Encourage students to respect the environment and to have positive attitudes toward the environment.
- Encourage students to interact with their own environment.
- These units encourage students confidence about themselves.
- These units are suitable in the age of knowledge explosion.
- These units do not concentrate on memorising like the units used in the schools.
- The style used in these units was very good.
- The use of problem solving approaches in these units, which connect students to their environment.
- These units encourage group work.
- These units train students to accept knowledge based on scientific evidence.
- Teachers are helped to find out the individual differences among students.

- These units encourage students to be active learners.
- These units develop students' attitudes toward the scientific research.

The only student who said 'no' thought that the situation in schools would not help the application of these units. Thus the school situation needs to be changed first before applying the units. Their responses are very positive and show how the student teachers are aware of the needs of their future pupils.

4. What do you think the units do for you?

The following are the most common comments:

- Encourage scientific thinking (24 students out of 51).
- Increase students' scientific knowledge (23 out of 51).
- Encourage students to show their own ideas (11 out of 51).
- Show that the scientific knowledge is not just white or black (5 out of 51).
- Connect students to their environment (4 out of 51).
- Develop the high cognitive skills (4 out of 51).
- Develop the logic thinking in order to solve problems (3 out of 51).
- Training students in the team-work (3 out of 51).
- Measure the practicality of students' ideas and their level of thinking (2 out of 51).
- Increase students' awareness (2 out of 51).
- Encourage self-learning (2 out of 51).
- Make students active learner (2 out of 51).
- Build units to fit the students' levels (2 out of 51).
- Related science to every day life (2 out of 51).
- Make the learning process effective and practical (2 out of 51).
- Find out students' ability to criticise scientifically (2 out of 51).
- Train students about some teaching methods (3 out of 51).
- Encourage students to do scientific research (1 out of 51).
- Find out students ability to evaluate some teaching methods (1 out of 51).
- Change the general styles in teaching science which is based on memorising (1 out of 51).
- Extending the length of keeping the scientific knowledge (1 out of 51).

- Teach students how to assess the scientific knowledge (1 out of 51).
- Train students to solve problems (1 out of 51).
- Tackle the individual differences among students (1 out of 51).
- Increase the students' confidence about themselves (1 out of 51).

The results show that only five students seem to find out the main aim for these teaching units. However, the change in students' perceptions were measured by the questionnaire and showed that their perceptions were developed. This suggests that student's perceptions of learning can be developed without students really being aware of this.

However, nearly half the students saw encouragement towards scientific thinking is an aim and, of course, this could include a deeper appreciation of the nature of scientific knowledge.

8.7 CONCLUSION

The analyses in this chapter suggest the following:

- The teaching units have been successful in moving students towards C position in their perceptions of knowledge. This is encouraging in that this was the main aim of four of five units.
- The units appear to have a little effect on their perceptions of their own role of learning but this was not an aim of any of these units.
- One unit focused on assessment and there were some positive moves (towards Perry position C) with some questions with the experimental group. This is encouraging but it is unlikely that only one teaching unit can change students' perceptions of assessment in a very strong way while their college experience of assessment tends to reflects Perry A type behaviour.
- The units appear to have had some effect on students' perceptions of the role of lecturer. Although this was not an aim of units, their very structure changes the role of the lecturer.
- The presence of the development of C type responses in those areas, which reflect the aims of the units and the structure of the units along with the absence of

similar development in the other areas are strong evidence of the impact of the units.

- The results from the interview show that the majority of students enjoy studying these teaching units and they gave different things they liked about these units.
- Despite the positive changes caused by these teaching units only 5 out of 51 students seems to find out the main aims of these units. This may lead us to the assumption that students' learning perceptions changed by changing the teaching materials and teaching approaches used in ordinary teaching of science although the general aims of teaching seem for the students to be teaching science. Perhaps, they were more aware but did not state this explicitly.
- The vast majority of students support applying the same approach, used in these units, in schools.
- The majority of students think that these units were built to: encourage scientific thinking, increase students' scientific knowledge and encourage students to show their own ideas. At the same time, the results show that the students like these units.

CHAPTER NINE

CHAPTER NINE
CONCLUSION AND RECOMENDATIONS

Initially, this study was set up to investigate the development of science students' perceptions of learning during their study years in the education colleges in the Sultanate of Oman. The aim was to establish a clear base-line of students' perceptions of learning so that curriculum intervention could be introduced in the light of the patterns of results gained. Eight questions were set up in the first part of this study:

1. How do the students' perceptions of the teacher's role change over their study years in the education colleges?
2. How do the students' perceptions of the student's role change over their study years in the education colleges?
3. How do the students' perceptions of the nature of scientific knowledge change over their study years in the education colleges?
4. How do the students' perceptions of assessment change over their study years in the education colleges?
5. Has the student's intellectual development improved as they go from year one (age 15) in secondary school to final year in Education College?
6. What is the relationship between college students' academic performance and their intellectual development?
7. Is their any significant difference between males and females in terms of their perceptions of learning?
8. Is there any significant difference between secondary arts stream and science stream students' in term of their perceptions of learning?

To answer these questions a survey was carried out in the education colleges and in secondary schools based on a questionnaire.

9.1 CONCLUSIONS FROM THE BASELINE MEASURMENT

The baseline measurement was carried out in order to answer these questions and to be a starting point for the field experiment. A large survey was completed in secondary schools and education colleges with over 2000 students. The results showed that college students have better perceptions of learning than secondary schools students in general. This may suggest that education colleges have positive effects on students' perceptions, or students maturing from age 15-22 is what is being observed.

The results also indicated that there was growth in students' intellectual development over the study years with a small decline in the final college's year for some questions. The decline in the final year may be related to students' fear of their future after they finished their study and look for work (Selepeng, 2000).

The analysis of students' responses to questions related to the four main areas of Perry intellectual development showed that there is growth in students' perceptions about the student's role, the lecturer's role, the nature of scientific knowledge and assessment. However, in students' perceptions about the nature of scientific knowledge, the percentages of students in C positions were very low in general in most questions related to this area. In questions related to students' perceptions about assessment, the percentages of students in C position were relatively high in three of these questions but low in the other. Students' perceptions of assessment may also be a problem area.

The results revealed that, generally, academic performance positively correlates with students' intellectual development. In questions where the correlations were significant, they were positive correlations. This may suggest that those students who are good in academic performance tend to be more intellectually developed. This result agrees with what had been found by Byrne (2001).

The results also showed that females in general are more intellectually developed than males. This observation could simply be because the academic quality of females' entrance to colleges in Oman is higher than that of males, females holding teaching in higher regard in Omani culture. Off course, it is well known that girls mature faster than boys and female students tend to exhibit more conscientious work habits in general.

It was noticed that science stream students in secondary schools are more intellectually developed than arts students when it comes to the students' perceptions about learning science, which may reflect the contextual nature of the Perry scheme for intellectual development.

From all these findings, it is clear that there were some problems mainly in students' perceptions about the nature of scientific knowledge and a partial problem in their perceptions about assessment. To tackle these problems teaching materials were developed and an experimental study was carried out.

9.2 CONCLUSIONS FROM THE FIELD EXPERIMENT

As a result of the findings from the baseline measurement, five teaching units were devised and applied in the second year in one of the education colleges. The aim was to see whether Perry C behaviour could be encouraged by means of a small curriculum intervention. Four areas were explored:

- *Lecturer's role*
- *Student's role*
- *Nature of scientific knowledge*
- *Assessment*

The teaching materials were devised mainly to develop students' perceptions about the nature of scientific knowledge while one unit worked at assessment. After analysing the pre- and post- questionnaires for experimental and control groups, the results indicated that the approach used in the teaching units had a positive effect in many of the questions related to the Perry scheme. The key improvement was clearly in the nature of scientific knowledge, which was the main aim. The results also showed that there was some positive improvement in assessment area. A positive improvement was also noticed in all questions related to the role's of lecturer. This probably arose because of the style of the units.

In the area of the student's role, no general pattern was noticed although in some questions there were positive changes. However, the student's role area was not an aim from the beginning since the percentages of students at C position in questions related to this area were high. Simply teaching science clearly does not guarantee an understanding of the nature of scientific knowledge. The very structure of the units demanded students interaction with issues relating to the nature of scientific knowledge. The students' interview results show that the majority of students like these teaching units and they think that this approach can be applied in school science. They also think that these units were teaching them scientific knowledge, were promoting scientific thinking, developing their problem solving skills and teaching them some new teaching methods. The idea of putting students into the centre of the education process and giving them the opportunity to show their ideas seemed to be admired by most of the students.

9.3 FINAL CONCLUSIONS

The results of this study revealed that science teacher training programmes at education colleges in the Sultanate of Oman has succeeded in developing students perceptions about student's role and lecturer's role. It is also partially successful in developing students perceptions about assessment. In students' perceptions about the nature of scientific knowledge, there was slight development although their perceptions were very low. The results also show that there is a decline in students' intellectual development in the final year of their study at education colleges.

The results also showed that students' perceptions of learning, especially students' perceptions of the nature of scientific knowledge and assessment can be improved by curriculum intervention. Some teaching materials should draw students' attention to thinking about the nature of scientific knowledge. This can be done by putting students in situations, where there is no right answer. This approach was successful despite its' short length and it may have had more positive effects if it applied over a longer period.

In summary:

- Growth in C behaviour was observed from age 15 to age 22.
- There was a drop in Perry C behaviour in the final year in education colleges.
- The levels of Perry behaviour:

Table 9.1: The levels of Perry behaviour

Area	Growth
The lecturer's role	Generally good
The student's role	Generally good
The nature of scientific knowledge	Very poor
Assessment	Variable

- Short curriculum intervention (5 units) achieved:

Table 9.2: The changes in students, perceptions of learning

Area	Change
The lecturer's role	Rise
The student's role	No change
The nature of scientific knowledge	Considerable rise
Assessment	Slight rise

- It appears possible to enhance intellectual development by means of small changes to the curriculum. This reveals the power of assessment procedure to enhance the intellectual development. Assessment has a powerful influence within the education process. If students are always rewarded for recalling knowledge then they will not be encouraged to use other skills. However, if skills other than memorising are rewarded, students intellectual development may be enhanced.

9.4 RECOMENDATIONS WITHIN EDUCATION COLLEGES IN OMAN CONTEXT

- There should be a procedure to measure the changes in students' perceptions of learning over their study years in the education colleges in order to ensure that students at these colleges develop positively over their study years.
- Students' perceptions of the nature of scientific knowledge should be given great attention. The positive change in students' perceptions about the nature of scientific knowledge could be improved through curriculum intervention by

the same approach used in the teaching materials especially if done over a long period of time.

- It is important for the colleges to re-think their assessment aims and procedures to increase the credit for more Perry's C type skills. This is likely to lead to the demonstration of Perry C behaviour.

9.5 WIDER RECOMENDATIONS

Although science education students were used for this study, the finding may be relevant to students studying science in general. Many studies in Perry scheme area were concentrated in measuring intellectual development. There are only few studies about how to enhance intellectual development. Finster (1991) tried to suggest theoretically some ideas to enhance students' intellectual development. Later, Mackenzie (1999) made a breakthrough when she found out that problem based learning helped medical students to develop their intellectual development better than a traditional course. However, Mackenzie was measuring the effects of a total course change. This is not easy to introduce. This study showed that students' intellectual development could be enhanced through curriculum intervention on a small scale.

9.6 SUGGESTIONS FOR FURTHER WORK

- *The long-term effects of these teaching materials can be studied. Students' perceptions of learning can be measured after one or two years of applying the teaching materials.*

- *Compare the university's students intellectual development with other people who are in the same age but not going through university experiences in order to find out the difference between them.*

- *A comparison study could be done between intellectual development of students in different scientific specializations: biology, physics and chemistry at university levels.*

- *A study can be done to find out how can changing assessment alter students' intellectual development.*

- *A study can be done to find out how students' intellectual development changes after they leave university.*

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APPENDIXES

APPENDIX A

College questionnaire (English)

The Way I like to Learn Science

College: Sohar ☐ Ristaq ☐ Ibri ☐ Nizwa ☐ Sur ☐ Salalah ☐

Sex: Male ☐ Female ☐

Specialization: secondary science teacher ☐ Basic education science teacher ☐

Year: First ☐ Second ☐ Third ☐ Fourth ☐

This questionnaire is part of a study which aims to find what your views are about teaching and learning science. Your response will be treated confidentially and will not affect your College results

You are providing with pairs of opposing statements with six boxes between. By ticking ONE of the boxes you can show which statement you agree with and how strongly your agreement is.
Here is an example:

Statement							*Statement*
I like to hear radio while I am studying							*I can not stand any background noise when I am studying*

If you tick the first left box, it means you agree strongly with left-hand statement. If you tick the second box, it means you favour the left-hand statement but less strongly. If you tick the third box, it means you slightly favour the left-hand statement. The other three boxes on the right would show agreement with the right-hand statement.

Part A
Tick (√) the box which most closely reflects your views

	Statement							Statement
1	In order to pass my courses, I need to study just what the lecturer tell me							I do not have to rely totally on the lecturer. Part of my learning is to work things out myself
2	I cannot be wrong if I accept what the lecturer says. If I question anything, I might end up failing							I do not believe in just accepting what the lecturer says without question. Success involves thinking for myself
3	I believe it is the job of the lecturer to supply me with all the knowledge I need							The duty of the lecturer is not to teach me everything, but to help me to think for myself.
4	I think teachers should avoid teaching materials that they know students will find difficult.							lecturer should aim to provide challenges to their students by introducing difficult topics.
5	It is good to work with other students because, by listening to their points of view, I can correct my ideas.							I prefer not to work with other students because then I stand less chance of picking up wrong ideas.
6	All one has to do in science is to memorise things.							Understanding science is the key part of science study.
7	I do not believe that all scientific knowledge represents the 'absolute truth'.							We cannot call anything scientific knowledge if it is not absolutely true.
8	I do not like short questions as they do not give me the chance to explain what I know and understand.							I prefer to learn the facts and then be tested on them in short questions
9	In exams I prefer questions which are based on what the lecturer taught.							In exams, I like questions that give me the scope to go beyond what is taught and show my ability to think
10	I believe that what should matter in exams is the quality of my answers, not how much I write.							In exams, I expect to be rewarded for giving as much information as possible.

Part B

Tick (√) the box which most closely reflects your views

	Statement	Strongl\ agree	Agree	Jncertai	Disagre	3trongly lisagree
1	Sometimes there seem to be so many ways of looking at science that I feel confused about what is right and wrong					
2	Sometimes I find I learn more about a subject by discussing it with other students than I do by sitting and revising at home					
3	There is not any point in class teaching, which include things which will not be in the exam					
4	If I have the choice of written comments or a specific mark at the end of a piece of science coursework, I would choose the comments					
5	It is a waste of time to work on problems which have no possibility of producing a clear-cut, unambiguous answer					
6	I feel uncomfortable when I am left to express an opinion, not knowing the view the lecturer feels					
7	A good thing about learning science is the fact that everything is so clear-cut: either right or wrong					
8	I like exams which give me an opportunity to show I have ideas of my own					

Thank you for your help

Abdullah Al-shibli
Centre for Science Education
University of Glasgow
Scotland - UK

APPENDIX B
School questionnaire (English)

The Way I like to Learn Science

School:……………………………………………………….

Sex: *Male* ☐ *Female* ☐

Stream(just for secondary 1 and 2): *Art* ☐ *science* ☐

Year: *First* ☐ *Second* ☐ *Third* ☐

This questionnaire is part of a study which aims to find what your views are about teaching and learning science. Your response will be treated confidentially and will not affect your College results

You are providing with pairs of opposing statements with six boxes between. By ticking ONE of the boxes you can show which statement you agree with and how strongly your agreement is.
Here is an example:

Statement							*Statement*
I like to hear radio while I am studying							*I can not stand any background noise when I am studying*

If you tick the first left box, it means you agree strongly with left-hand statement. If you tick the second box, it means you favour the left-hand statement but less strongly. If you tick the third box, it means you slightly favour the left-hand statement. The other three boxes on the right would show agreement with the right-hand statement.

Part A

Tick (√) the box which most closely reflects your views

	Statement							Statement
1	In order to pass my courses, I need to study just what the teacher tell me							I do not have to rely totally on the teacher. Part of my learning is to work things out myself
2	I cannot be wrong if I accept what the teacher says. If I question anything, I might end up failing							I do not believe in just accepting what the teacher says without question. Success involves thinking for myself
3	I believe it is the job of the teacher to supply me with all the knowledge I need							The duty of the teacher is not to teach me everything, but to help me to think for myself.
4	I think teachers should avoid teaching materials that they know pupils will find difficult.							Teachers should aim to provide challenges to their pupils by introducing difficult topics.
5	It is good to work with other pupils because, by listening to their points of view, I can correct my ideas.							I prefer not to work with other pupils because then I stand less chance of picking up wrong ideas.
6	All one has to do in science is to memorise things.							Understanding science is the key part of science study.
7	I do not believe that all scientific knowledge represents the 'absolute truth'.							We cannot call anything scientific knowledge if it is not absolutely true.
8	I do not like short questions as they do not give me the chance to explain what I know and understand.							I prefer to learn the facts and then be tested on them in short questions
9	In exams I prefer questions which are based on what the teacher taught.							In exams, I like questions that give me the scope to go beyond what is taught and show my ability to think
10	I believe that what should matter in exams is the quality of my answers, not how much I write.							In exams, I expect to be rewarded for giving as much information as possible.

Part B

Tick (√) the box which most closely reflects your views

	Statement	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
1	Sometimes there seem to be so many ways of looking at science that I feel confused about what is right and wrong					
2	Sometimes I find I learn more about a subject by discussing it with other pupils than I do by sitting and revising at home					
3	There is not any point in class teaching, which include things which will not be in the exam					
4	If I have the choice of written comments or a specific mark at the end of a piece of science coursework, I would choose the comments					
5	It is a waste of time to work on problems which have no possibility of producing a clear-cut, unambiguous answer					
6	I feel uncomfortable when I am left to express an opinion, not knowing the view the lecturer feels					
7	A good thing about learning science is the fact that everything is so clear-cut: either right or wrong					
8	I like exams which give me an opportunity to show I have ideas of my own					

Thank you for your help

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APPENDIX C

College questionnaire (Arabic)

الطريقة التي أحب أن أدرس بها العلوم

الرقم الجامعي:..

الكلية: صحار ☐ الرستاق☐ عبري ☐ نزوى ☐ صلاله ☐

الجنس: ذكر ☐ أنثى ☐

التخصص: معلم علوم (إعدادي / ثانوي) ☐ معلم تعليم أساسي (علوم / رياضيات) ☐

السنه : أولى ☐ ثانيه ☐ ثالثه ☐ رابعه ☐

الاستبيان الذي بين يديك هو جزء من دراسة تهدف التعرف على وجهات نظرك عن تدريس وتعلم العلوم ، وتجدر الإشارة هنا إلى أن إجاباتك سوف تعامل بسريه ولن تستخدم إلا لأغراض البحث العلمي ولن تؤثر على نتيجتك في الكلية.

سيتم في السؤال القادم عرض أزواج من العبارات المتعاكسة مع وجود ستة صناديق بينها، يمكنك عن طريق وضع (✓) في أحـد هذه الصناديق السته أن توضح مع أي عبارة تتفق والى أي مدى تتفق معها، وذلك كما في المثال الآتي:

	العبـــــــــــــــــــارة							العبـــــــــــــــــــارة
1	أحب الاستماع للمذياع عندما أدرس							لا يمكنني أن أدرس مع وجود أي صوت

إذا وضعت علامة (✓) في المربع الأول من اليمين فإن ذلك يعني أنك تتفق بشده مع العبارة التي في اليمين أما إذا اخترت الصندوق الثاني من اليمين فذلك يعني تتفق أكثر مع العبارة التي في اليمين ولكن بدرجه أقل من المربع الأول، اختيارك للصندوق الثالث من اليمين يعني أنك تميل للاتفاق بدرجه بسيطة مع العبارة التي في اليمين. أما بالنسبة للصناديق الثلاثة الأخرى في اليسار فإنها توضح مدى الإتفاق مع العبارة التي في اليسار بنفس الطريقة السابقة.

الجزء الاول:

الآن ضع علامة (✓) في الصندوق الذي يمثل وجهة نظرك

	العبـــــــــــــــــــارة							العبـــــــــــــــــــارة
1	كل ما أحتاجه لكي أنجح في مقرر ما هو أن أدرس ما يقوله المحاضر							لا ينبغي أن أعتمد بالكامل على المحاضر ذلك أنه جزء من عملية التعلم هو استخراج بعض الأمور بنفسي
2	لا ينبغي علي تقبل كل ما يقوله المحاضر دون أسئلة ذلك أن النجاح يتضمن استخراج بعض الأمور بنفسي							لا يمكن أن أكون على خطأ إذا تقبلت ما يقوله المحاضر، وإذا سألت عن أي شيء فإن ذلك قد يؤدي إلى رسوبي
3	من واجب المحاضر تزويدي بكل المعرفة التي أحتاجها							لا تنحصر مسؤلية المحاضر في تدريسي كل شئ ولكن مساعدتي على التفكير بنفسي
4	ينبغي على المحاضرين تجنب جميع الموضوعات التي يعرفون أنها ستكون صعبة على الطلاب							ينبغي أن يهدف المحاضرون لوضع بعض التحدي لطلابهم عن طريق طرح بعض المواضيع الصعبة
5	من المفيد العمل مع الطلاب الآخرين حيث يمكنني أن أصحح بعض أفكاري بالاستماع لآرائهم							أفضل عدم العمل مع الطلاب الآخرين ذلك أن فرصة الحصول على بعض الأفكار الخاطئة تكون أقل
6	كل ما ينبغي عمله في العلوم هو حفظ الأشياء							الفهم هو العامل الأساسي والمهم في دراسة العلوم
7	لا أعتقد أن جميع المعرفة العلمية تمثل الحقيقة المطلقة							لا يمكن أن نطلق على أي شي أنه معرفة علمية إلا إذا كان صحيحا بصوره مطلقة
8	لا أحب الأسئلة القصيرة ذلك أنها لا تتيح لي فرصة شرح ما أعرف							أفضل أن أدرس الحقائق العلمية ثم أمتحن فيها بأسئلة قصيرة الإجابة
9	في الامتحانات أفضل الأسئلة التي توضع في ضوء ما شرحه المحاضر							في الامتحانات أفضل الأسئلة التي تذهب أبعد مما شرحه المحاضر وذلك لأبدي قدرتي على التفكير
10	العامل المهم في الامتحانات هو جودة الإجابة لا كمها							في الامتحانات أتوقع أن أكافئ على إعطاء أكبر قدر من المعلومات

الجزء الثاني:
ضع علامة (✓) في الصندوق الذي يمثل مدى اتفاقك مع العبارات الآتية

	العبـــــــــــــــــــــــــــــارة	موافق بشدة	موافق	غير متأكد	غير موافق	غير موافق بشدة
1	في بعض الأحيان تتعدد وجهات النظر حول العلوم الأمر الذي يجعلني محتارا ما الصح وما الخطأ					
2	في بعض الأحيان أجد نفسي أتعلم أفضل عند مناقشة المادة مع الطلاب الآخرين عن مراجعة المادة بنفسي في البيت					
3	لا جدوى من التدريس الصفي إذا لم يحتوي على شيء سيأتي في الامتحان					
4	إذا كان علي أن أختار بين إعطائي درجة أو تقرير فيه ملاحظات عن أدائي في واجب العلوم فسأختار التقرير					
5	من المضيعة للوقت العمل في مسألة لا يمكن أن تعطي حلا قاطعا واضحا					
6	أشعر بعدم الارتياح عندما يطلب مني أن ابدي رأي في موضوع دون أن أعرف وجهة نظر المحاضر فيه					
7	الشيء الجيد في تعلم العلوم أن كل شئ قاطع إما صح أو خطأ					
8	أحب الامتحانات التي تعطيني فرصة أن أعرض أفكاري الذاتية					

شاكرين لكم حسن تعاونكم
عبدالله بن علي بن سعيد الشبلي
مركز مناهج وطرق تدريس العلوم
جامعة جلاسكو
سكوتلندا – المملكة المتحدة

APPENDIX D

School questionnaire (Arabic)

الطريقة التي أحب أن أدرس بها العلوم

المدرسة:..

الجنس: ذكر ☐ أنثى ☐

التخصص:(بالنسبة للأول ثانوي يختار حسب رغبته في السنة القادمة) علمي ☐ أدبي ☐

الصف: أول ثانوي ☐ ثاني ثانوي ☐ ثالث ثانوي ☐

الاستبيان الذي بين يديك هو جزء من دراسة تهدف التعرف على وجهات نظرك عن تدريس وتعلم العلوم ، وتجدر الإشارة هنا إلى أن إجاباتك سوف تعامل بسريه ولن تستخدم إلا لأغراض البحث العلمي ولن تؤثر على نتيجتك في المدرسة.

سيتم في السؤال القادم عرض أزواج من العبارات المتعاكسة مع وجود ستة صناديق بينها، يمكنك عن طريق وضع (✓) في أحـد هذه الصناديق الستة أن توضح مع أي عبارة تتفق وإلى أي مدى تتفق معها، وذلك كما في المثال الآتي:

	العبارة							العبارة
1	أحب الاستماع للمذياع عندما أدرس							لا يمكنني أن أدرس مع وجود أي صوت

إذا وضعت علامة (✓) في المربع الأول من اليمين فإن ذلك يعني أنك تتفق بشده مع العبارة التي في اليمين أما إذا اخترت الصندوق الثاني من اليمين فذلك يعني تتفق أكثر مع العبارة التي في اليمين ولكن بدرجه أقل من المربع الأول، اختيارك للصندوق الثالث من اليمين يعني أنك تميل للإتفاق بدرجه بسيطة مع العبارة التي في اليمين. أما بالنسبة للصناديق الثلاثة الأخرى في اليسار فإنها توضح مدى الإتفاق مع العبارة التي في اليسار بنفس الطريقة السابقة.

الجزء الاول:

الآن ضع علامة (✓) في الصندوق الذي يمثل وجهة نظرك

	العبارة							العبارة
1	كل ما أحتاجه لكي أنجح في مواد العلوم هو أن أدرس ما يقوله المعلم							لا ينبغي أن أعتمد بالكامل على المعلم ذلك أنه جزء من عملية التعلم هو استخراج بعض الأمور بنفسي
2	لا ينبغي علي تقبل كل ما يقوله المعلم دون أسئلة ذلك أن النجاح يتضمن استخراج بعض الأمور بنفسي							لا يمكن أن أكون على خطأ إذا تقبلت ما يقوله المعلم، وإذا سألت عن أي شيء فإن ذلك قد يؤدي إلى رسوبي
3	من واجب المعلم تزويدي بكل المعرفة التي أحتاجها							لا تنحصر مسؤلية المعلم في تدريسي كل شئ ولكن مساعدتي على التفكير لنفسي
4	ينبغي على المعلمين تجنب جميع الموضوعات التي يعرفون أنها ستكون صعبة على الطلاب							ينبغي أن يهدف المعلمون لوضع بعض التحدي لطلابهم عن طريق طرح بعض المواضيع الصعبة
5	من المفيد العمل مع الطلاب الآخرين حيث يمكنني أن أصحح بعض أفكاري بالاستماع لآرائهم							أفضل عدم العمل مع الطلاب الآخرين ذلك أن فرصة الحصول على بعض الأفكار الخاطئة تكون أقل
6	كل ما ينبغي عمله في العلوم هو حفظ الأشياء							الفهم هو العامل الأساسي والمهم في دراسة العلوم
7	لا أعتقد أن جميع المعرفة العلمية تمثل الحقيقة المطلقة							لا يمكن أن نطلق على أي شي أنه معرفة علمية لا إذا كان صحيحا بصوره مطلقة
8	لا أحب الأسئلة القصيرة ذلك أنها لا تتيح لي فرصة شرح ما أعرف							أفضل أن أدرس الحقائق العلمية ثم أمتحن فيها بأسئلة قصيرة الإجابة
9	في الامتحانات أفضل الأسئلة التي توضع في ضوء ما شرحه المحاضر							في الامتحانات أفضل الأسئلة التي تذهب أبعد مما شرحه المعلم وذلك لأبدي قدرتي على التفكير
10	العامل المهم في الامتحانات هو جودة الإجابه لا كمها							في الامتحانات أتوقع أن أكافئ على إعطاء أكبر قدر من المعلومات

الجزء الثاني:

ضع علامة (✓) في الصندوق الذي يمثل مدى اتفاقك مع العبارات الآتية

	العبـــــــــــــــــــــــــــارة	موافق بشدة	موافق	غير متأكد	غير موافق	غير موافق بشدة
1	في بعض الأحيان تتعدد وجهات النظر حول العلوم الأمر الذي يجعلني محتارا ما الصح وما الخطأ					
2	في بعض الأحيان أجد نفسي أتعلم أفضل عند مناقشة المادة مع الطلاب الآخرين عن مراجعة المادة بنفسي في البيت					
3	لا جدوى من التدريس الصفي إذا لم يحتوي على شيء سيأتي في الامتحان					
4	إذا كان علي أن أختار بين إعطائي درجة أو تقرير فيه ملاحظات عن أدائي في واجب العلوم فسأختار التقرير					
5	من المضيعة للوقت العمل في مسألة لا يمكن أن تعطي حلا قاطعا واضحا					
6	أشعر بعدم الارتياح عندما يطلب مني أن ابدي رأي في موضوع دون أن أعرف وجهة نظر المعلم فيه					
7	الشيء الجيد في تعلم العلوم أن كل شئ قاطع إما صح أو خطأ					
8	أحب الامتحانات التي تعطيني فرصة أن أعرض أفكاري الذاتية					

شكرا على حسن تعاونك
عبدالله بن علي بن سعيد الشبلي
مركز مناهج وطرق تدريس العلوم
جامعة جلاسكو
سكوتلندا – المملكة المتحدة

APPENDIX E

Centre for science education letter

The Centre for Science Education

From: Dr Norman Reid
Director
Telephone: 0141-330-5172
Fax: 0141-330-3755
E-Mail: N.Reid@mis.gla.ac.uk

UNIVERSITY
of
GLASGOW

2 April 2001

To Whom It May Concern

Mr Abdullah Ali Said Alshibli

I write to confirm that Mr Abdullah Ali Said Alshibli is a matriculated (matriculation number: 0009674) postgraduate student, studying for his PhD in the Centre for Science Education.

Dr Norman Reid

CENTRE FOR SCIENCE EDUCATION
Kelvin Building, University of Glasgow, GLASGOW G12 8QQ
Director: Dr Norman Reid: 0141-330-5172
Emeritus Professor: Professor Alex. H. Johnstone
Direct Line: 0141-330-6565 Fax: 0141-330-3755
Web Site: http://www.gla.ac.uk/centres/scienceeducation

APPENDIX F

Permission's letter from Ministry of Education (Oman)

بسم الله الرحمن الرحيم

سلطنة عُمان
وزارة التربية والتعليم
المكتب الفني للدراسات والتطوير

الرقم: ... ١٧٩

التاريخ: ... ١٤/٤/٢٠٠١م

لعناية ...

الفاضل / مدير عام المديرية العامة للتربية والتعليم لمنطقة الباطنة شمال ... المحترم

السلام عليكم ورحمة الله وبركاته ... وبعد ...

أود إفادتكم بأن الفاضل / عبدالله بن علي بن سعيد الشبلي مدرس بكلية التربية بصحار يقوم حاليا بالتحضير لرسالة الدكتوراه في تخصص مناهج وطرق تدريس العلوم – جامعة جلاسكو – المملكة المتحدة وينوي الباحث تطبيق الاستبانة المرفقة بالمدارس ... بمديريتكم وهي جزء من دراسة تهدف الى التعرف على النمو الفكري لطلاب ... التربية حيث سيتتبع البحث هذا النمو من المرحلة الثانوية وحتى نهاية الفترة الجامعية في كلية التربية.

يرجى التكرم بالايعاز لتسهيل مهمة المذكور .
شاكرة لكم كريم تعاونكم .

وتفضلوا بقبول وافر الاحترام والتقدير ،،،

د. سناء ...

مديرة المكتب الفني للدراسات والتطوير

APPENDIX G

Lecturer/Teacher instruction sheet

Dear Lecturer / Teacher,

Thank you for your cooperation in conducting this questionnaire which will help in my study.

In order to ensure the maximum benefit from this questionnaire, please do the following:

1- Before distributing questionnaires, tell the students this questionnaire is part of a study which help to improve science teaching in future.
2- Tell them also that there are no correct answers for these questions. Their personal views are important.
3- Give the students 15-20 minutes to answer the questionnaire.

Finally I would like to thank you again.

Sincerely,
Abdullah Ali Said Al-Shibli

APPENDIX H

The letter from the Directorate General of Colleges (Ministry of Higher Education – Oman)

686126

بسم الله الرحمن الرحيم

Sultanate of Oman
Ministry of Higher Education
Directorate General of Colleges
& Higher Institutes
Office of the Director General
No. : ....
Date : ....

سلطنة عمان
وزارة التعليم العالي
المديرية العامة للكليات والمعاهد العليا
مكتب المدير العام

الرقم : ....
التاريخ : ....
الموافق : ....

الأفاضل/عمداء كليات التربية المحترمين

السلام عليكم ورحمة الله وبركاته

[redacted]

نفيدكم بأن الفاضل المذكور أعلاه المدرس المساعد بكلية التربية بصحار والمبتعث حاليا لإكمال دراساته العليا للحصول على درجة الدكتوراه في طرق تدريس العلوم يزمع القيام بتوزيع استبيان على أقسام العلوم بالكليات اعتبارا من ٢٠٠١/٤/٧م.

عليه يرجى التكرم بعمل اللازم نحو توجيه المختصين لديكم لتسهيل مهمته.

شاكرين لكم حسن تعاونكم

وتفضلوا بقبول فائق الاحترام،،،

د. محمد بن سليمان البندري

مدير عام كليات التربية

سلطنة عمان، ص.ب ٨٢ روي، الرمز البريدي ١١٢، هاتف ٦٨٦٣٣٣، فاكس ٦٨٥٣٧٨
Sultanate of Oman, P.O. Box 82, Ruwi, Postal Code 112, Tel. : 686333, Fax : 685378
E-mail:colleges@gto.net.om & colleges001@hotmail.com

APPENDIX I

Chi-square test (χ^2)

Chi-square Test (χ^2)

Chi-square test is one of the most widely used tests for statistical data generated by non-parametric analysis. There are two different of applications of chi-square test. These are used in this study.

(1) Goodness of Fit Test

This tests how well the experimental (sampling) distribution fits the control (hypothesised) distribution. An example of this could be a comparison between a group of experimentally observed responses to a group of control responses. For example,

	Positive	**Neutral**	**Negative**	
Experimental	55	95	23	N(experimental) = 173
Control	34	100	43	N(control) = 177
				(using raw numbers)
A calculation of observed and expected frequencies lead to				
	Positive	**Neutral**	**Negative**	
fo = observed frequency	55	95	23	
fe = expected frequency	33.2	97.7	42	

Where *fe* = [N(experimental)/N(control)] X (control data) or (173/177) X (control data)

$$\chi^2 = \Sigma \frac{(fo - fe)^2}{fe}$$

$$\chi^2 = \frac{(55 - 33.2)^2}{33.2} + \frac{(95 - 97.7)^2}{97.7} + \frac{(23 - 42)^2}{42}$$

$$\boldsymbol{\chi^2 = 22.98}$$

The degree of freedom (df) for this comparison is 2. This comparison is significant at two degrees of freedom at greater than 1%. (χ^2 critical at 1% level = 9.21)

(2) Contingency Test

This chi-square test is commonly used in analysing data where two groups or variables are compared. Each of the variable may have two or more categories which are independent from each other. The data for this comparison is generated from the frequencies in the categories. In a study, the chi-square as a contingency test was used, for example, to compare two or more independent samples like, year groups, gender, or ages. The data is generated from one population group. 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)		

The expected frequencies are shown in brackets ( ), and are calculated as follows: e.g. 44 = (173/350) x 89

$$\chi^2 = \frac{(55-44)^2}{44} + \frac{(95-96)^2}{96} + \frac{(23-33)^2}{33} + \frac{(34-45)^2}{45} + \frac{(100-97)^2}{97} + \frac{(43-33)^2}{33}$$

$\chi^2 = 2.75 + 0.01 + 3.03 + 2.69 + 0.09 + 3.03$
$= \mathbf{11.60}$

At two degrees of freedom, this is significant at 1%. (χ^2 critical at 1% level = 9.21) The degree of freedom (df) must be stated for any calculated chi-square value. The value of the degree of freedom for any analysis is obtained from the following calculations:

df = (r-1) x (c-1)

where **r** is the number of rows and **c** is the number of columns in the contingency table.

Limitations on the Use of χ^2

It is know that when values within a category are small (i.e. 5, as proposed by some writers (Wiersma, 1995)), there is a chance that the calculation of c^2 may occasionally produce inflated results which may lead to wrong interpretations. In this study, in order to avoid dubious conclusions, a 10% category limit was imposed.

APPENDIX J

Kendall's tau-b correlation

Kendal's Tau-b correlation

In the 8 closed questions, the data are obtained on a five-point scale, from *'Strondly agree'* to *'strongly disagree'*. These data are categorical, not ratio, and no distribution (normal or otherwise) can be assumed. Using only five categories inevitably means that tied data are the norm.

If the data are coded on a 1-to-5 scale, then this implies, say, that an *'agree'* (being coded as 4) is worth twice as much as a *'disagree'* (being worth 2). Such a statement is meaningless and approaches depending on this are not used.

Kendal's Tau-b, as a correlation method, handles all these problems and was, therefore, chosen.the data were analysed using SPSS.

APPENDIX K

Baseline data

College data

GPA	Coll	Sex	Spe	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
2.18	1	1	1	1	6	1	6	6	1	6	5	5	2	6	3	1	4	2	1	1	1	1
2.85	1	1	1	4	1	6	6	6	3	6		1	1	6	5	2	1	1	3	1	1	1
2.98	1	1	1	3	5	2	1	1	1	6	2	5	1	1	2	2	1	3	1	2	1	1
1.79	1	1	1	2	6	1	6	4	1	5	5	2	3	1	3	2	4	2	2	2	1	1
1.24	1	1	1	1	4	2	3	1	2	4	4	4	1	1	2	1	4	3	4	2	1	1
2.22	1	1	1	2	5	1	4	5	4	5	4	4	5	4	2	1	1	1	2	3	1	1
2.8	1	1	1	4	3	2	6	6	2	4	4	5	5	2	2	1	4	2	2	3	1	1
2.61	1	1	1	2	6	1	2	6	1	6	2	6	5	6	2	1	2	3	1	4	1	1
2.42	1	1	1	4	2	5	5	2	2	5	5	2	5	5	2	2	4	2	4	4	1	1
2.53	1	1	1	4	6	1	1	3	1	6	2	2	6	1	4	1	5	3	2	5	1	1
2.12	1	1	1	4	6	2		6	1	6	5	1	5	5	2	1		3	2	1	2	1
2.48	1	1	1	4	6	1	6	6	2	6		1	6	1	4	2	4	2	3	1	2	1
2.53	1	1	1	4	6	2	1	6	1	6	5	6	1	3	2	1	1	3	1	2	2	1
2.09	1	1	1	2	6	1	6	2	1	6	5	6	5	1	1	2	2	2	3	2	2	1
2.52	1	1	1	3	4	4	1	5	6	5	1	1	6	4	1	1	3		4	2	2	1
2.29	1	1	1	4	2	1	3	4	1	4	5	6	4	6	4	2	5	3	2	3	2	1
2.56	1	1	1	4	4	1	5	5	3	5	2	3	6	4	4	1	5	2	3	3	2	1
2.36	1	1	1	4	2	1	1	1	6	6	3	3	1	2	2	2	2	4	3	3	2	1
2.43	1	1	1	2	2	1	5	1	1	2	2	4	1	4	1	2	4	2	4	3	2	1
2.01	1	1	1	1	4	2	5	4	1	4	5	3	6	1	3	4	4	4	4	3	2	1
2.73	1	1	1	3	1	1	6	6	1	6	6	6	1	1	3	1	1	1	1	4	2	1
2.12	1	1	1	1	4	3	2	3	2	6	3	2	3	5	2	1	2	2	1	4	2	1
2.88	1	1	1	2	6	2	1	1	1	3	6	1	1	3	3	2	2	3	1	4	2	1
3.12	1	1	1	4	4	3	5	5	1	4	1	4	5	4	1	2	5	2	3	4	2	1
2.31	1	1	1	1	2	3	5	4	3	6	5	4	5	1	4	4	2	1	4	4	2	1
2.76	1	1	1	4	6	2	3	5	1	6	5	5	2	2	4	2	3	1	4	4	2	1
1.41	1	1	1	1	5	3	6	3	4	6	1	1	1		2	2	5	2	4	4	2	1
2.51	1	1	1	3	4	3	4	2	1	4	4	6	1	2	1	2	4	3	1	5	2	1
2.23	1	1	1	2	2	1	1	4	5	6	5	6	6	6	4	2	5	3	4	5	2	1
2.76	1	1	1	4	6	3	1	6	1	6	2	5	6	6	3	1	2	4	5	5	2	1
2.18	1	1	1	2	5	1	5	5	1	4	1	1	1	3	5			3	3		2	1
2.89	1	1	1	4	3	1	6	6	1	6	6	6	5	1	4	1	2	2	1	1	3	1
1.98	1	1	1	1	4	2	4	5	2	4	2	1	4	5	2	4	3	2	2	1	3	1
2.06	1	1	1	1	4	2	2	4	6	4	1	4	1	1	3	1	3	2	2	2	3	1
3.02	1	1	1	2	4	6	1	4	1	4	4	1	5	2	2	2	3	5	2	2	3	1
2.6	1	1	1	3	2	1	5	2	1	6	4	5	6	1	1	2	2	2	4	2	3	1
2.57	1	1	1	4	6	3	5	6	1	6	1	5	6	1	2	1	5		4	2	3	1
2.48	1	1	1	2	6	1	6	5	1	5	6	1	6	5	3	2	5	4	5	2	3	1
1.86	1	1	1	1	4	1	5	1	6	4	5	4	1	1	2	3	2	1	1	3	3	1
3.49	1	1	1	4	2	2	6	5	1	6	6	6	1	6	2	2	4	2	1	3	3	1
2.07	1	1	1	2	3	2	5	2	3	3	2	3	2	2	1	2	5	3	3	3	3	1
2.34	1	1	1	4	4	2	5	4	1	4	4	1	2	4	5	2	5	3	4	3	3	1
2.27	1	1	1	4	2	5	6	1	1	6	6	2	1	2	2	3	1	2	1	4	3	1
2.11	1	1	1	4	1	1	2	6	1	6	6	6	4	5	3	1	2	3	2	4	3	1
3.07	1	1	1	2	6	2	1	5	1	6	2	2	1	6	2	1	5	3	2	4	3	1
2.18	1	1	1	3	1	2	6	3	2	6	1	2	5	1	2	4	3	1	3	4	3	1
2.25	1	1	1	3	6	1	6	6	1	6	5	6	2	5	3	2	4	3	3	4	3	1
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School data

sch	sex	spe	cla	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
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4	2	1	3	6	1	1	1	1	6	6	6	6	6	2	3	1		2	1	3	2
4	2	2	3	1	1	6	1	1	6	1	1	6	6	3	1	3	3	4	1	3	2
4	2	2	3	1	4	1	1	2	5	6	4	5	3	2		2			1	3	2
4	2	2	2	6	1	5		1	5	4	6	2	1	2	2	3	1	1	2	3	2
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4	2	2	2	2	3	1	2	2	5	4	4	2	1	2	2	3	3	1	2	3	2
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4	2	2	2	6	1	2	1	1	5	6	2	3	1	1	2	2	3	2	1		

APPENDIX L

Teaching units

Teaching units (English)

Which Candidate is The Best

Five persons apply for a job in a company as a security guard. All of them have similar experience and qualifications. However, a major factor to determine the best person for this job is by considering their body mass index. This index gives a good indication of fitness which is important to do the job properly. For that reason a scientific committee was formed to decide which one of them is the suitable person for the job. The committee has to choose just one of them.

What is the Body Mass index?

Body Mass Index (BMI) is one of the most accurate ways to determine when extra kilograms translate into health risks. BMI is a measure, which takes into account a person's weight and height to gauge total body fat in adults (age 19-70).

A BMI of 19 to 24.9 is considered a healthy weight. A BMI 25 to 29.9 is considered overweight; 30 to 39.9 obese and 40 very obese. A BMI of less than 19 is considered unsafe and may lack of muscle weight.

$$BMI = \frac{W}{h^2}$$

Where W is weight in kilograms and h is height in meters

Your task

As a group come to agreed answer. Discuss which candidate you will choose.

Name	Ahmed	Said	Ali	Issa	Rashid
Height	1.71m	1.85m	1.72m	1.93m	1.78m
Weight	68kg	73kg	75kg	80kg	74kg
Age	23	18	25	26	22

Works as a group:

- Calculate BMI for each applicant.
- Which applicants (if any) are unsuitable and why?
- Which candidate do you choose and why?
- Discuss what other information might help you make you decision?

You may ask to report your decision back.

Which Candidate is The Best
Tutor's Guide

Introduction:

This teaching unit is one of a set of teaching units devised for developing student teachers' perceptions of learning in the education colleges in the Sultanate of Oman. Beside developing mainly their perceptions of scientific knowledge they try to develop their perceptions of:

- Teacher role in science education.
- Students role science education.
- Assessment in science education.

To achieve these aims, students are given the opportunity to work in small groups to explore the nature of scientific knowledge. Through these units students are encouraged to use analysis, synthesis and evaluation of cognitive skills to achieve the aims.

At the end of this unit the student is expected to:

- Calculate the body mass index.
- Conclude from person body mass index his fitness.
- Appreciate that scientific evidence does not always lead to a clear cut black and white answer.

How the unit operate:

For students to gain the maximum benefit from this unit, the following procedures should be followed carefully. It is important that the students are allowed to interact in groups with the materials. The role of the tutor is that of manager rather than teacher. Do not become involved with groups unless they are completely confused.

(1) Divide students into groups of 3 and distribute the unit to all of them and give them 10 to 12 minutes to read the unit and answer the question within their group.

Possible Answer:

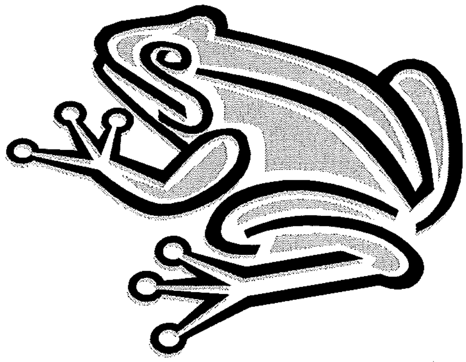
Name	Ahmed	Said	Ali	Issa	Rashid
BMI	23.2	21.3	25.3	21.4	23.3

From the table on the teaching unit and this table it is clear that :

- Ali could be excluded because from his BMI he is considered as an overweight person.
- Said could be excluded too because he is under 19 years.
- It is possible to distinguish the merits of other three easily simply on the basis of their BMI values.

Therefore, any decision between these three has to take into account other factors. No other factors given. Science sometimes operates like this in that the evidence does not allow a clear-cut conclusion to be drawn.

Special Frog



Part one

In a group of three try to answer the following questions

Some kinds of frogs have loose flaps of skin on their limbs.

As a group, discuss the possible function of loose flaps of skin on their limbs?

What is your agreed solution?

Record your agreed answer.

Part Two

Here is some more information about these frogs:

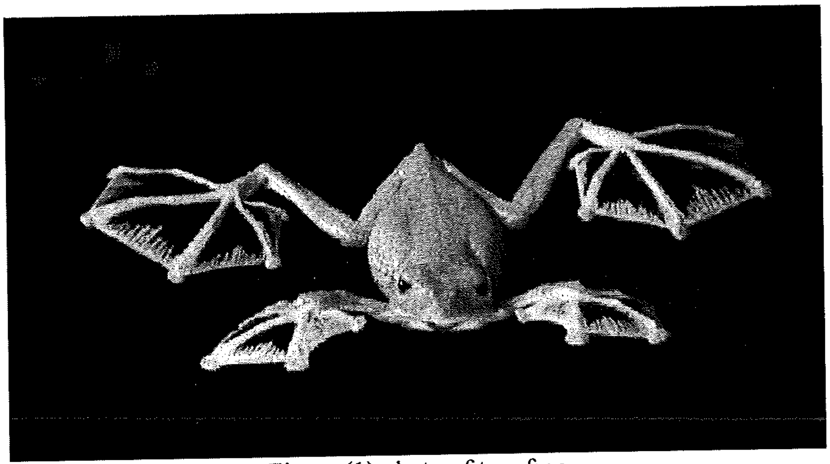


Figure (1) photo of tree frog

These kind of frogs are called tree frogs. Although they swim and breed in water, they spend most of their time on the trees. They are found in Brunei, Sumatra and southern Philippine Islands and other parts of the world.

In the light of the extra information, what do you conclude might be the function of the loose flap on their limbs?

Discuss this as a group and write your answer

Part Three

Here is even more information about these frogs:

These frogs glide from tree to tree for long distances. Furthermore, some of these frogs can make 180-degree turns in midair while they are gliding.

In the light of the extra information, what do you conclude might be the function of the loose flap on their lambs?

Discuss this as a group

Special Frog
Tutor's Guide

Introduction:

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- Teacher role in science education.
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- Assessment in science education.

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At the end of this unit the student is expected to:

- Have a brief idea about the flying frog.
- Realize that the knowledge driven from science may have to be changed if we find new information.

How the Unit Operates:

(1)

- Divide students in group of 3.
- Distribute part one of the unit to all students. Allow two minutes reading time.
- Ask students to write as groups and to choose a reporter for the group.
- Ask each group to give you their answer and write all answers on the board (the expected answer is that for swimming).

(2)

- Distribute the part two of this teaching units to all students and ask them to read it (give them two minutes).
- Ask them to answer the question within their group.
- Ask each group to give you their answer and write each group answer beside their previous answer (the expected answer is for gliding or still have same answer).

(3)

- Distribute the part three of this teaching units to all students and ask them to read it (give them two minutes).
- ask each group to give you their answer and write each group answer beside their previous answer (the expected answer is for gliding).
- Compare between first and second answers for each group and ask them to explain why their answer change.

Debriefing:

Try to discuss why their answers have been changed. Try to show students that the scientific knowledge is just the best understanding of a phenomena according to the information available for us. And in case we discovered new information it could change. The scientific knowledge could be changed if we find new evidence.

Possible answer:
The possible answers are included in parts 4, 7 and 9 in the how the unit operates section.

Which dam?

It is well known that water shortage is one of the main environmental issues in the Sultanate of Oman. In order to reduce this problem, the government has started to construct dams in different parts of the country. This year the government has decided to construct a new dam in Al-Batina. It is expected for the dam will last for around 50 years before any major repairs to be done. This dam, as the studies show, could be constructed in three possible positions. Each position has advantages and disadvantages.

Look at the table below and discuss as a group which position do you think is the best to build the dam.

	Position 1	Position 2	Position 3
Cost	2 millions R.O	1.2 millions RO	1.85 millions RO
Storage capacity	3 km^2	2.3 km^2	2.6 km^2
Maintenance Per Year	20,000 RO	21,500 RO	20,000 RO
Area flooded by dam	15 km^2	20 km^2	14.5 km^2

One member can write your agreed answers at the answer sheet 1

Answer sheet 1

1. In a group which dam is the best?

....

....

2. Your reasons for your choice are :

....

....

....

3. Are you confident this is the only correct answer?

………………………………………………………………………………………

………………………………………………………………………

4. Explain why?

....

....

....

....

Answer sheet 2

1. In a group which dam is the best?

....

....

2. Your reasons for your choice are :

....

....

....

3. Are you confident this is the only correct answer?

……………………………………………………………………………………………

……………………………………………………………………

4. Explain why?

....

....

....

....

Which Dam Units
Tutor's Guide

Introduction:

This teaching unit is one of a set of teaching units devised for developing student teachers' perceptions of learning in the education colleges in the Sultanate of Oman. Beside developing mainly their perceptions of scientific knowledge they try to develop their perceptions of:

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At the end of the unit student is expected to:

- Realize that in some scientific situations there is no one simple answer.
- Appreciate that there may be several factors, which have to be considered in taking decisions in science.

How The Unit Operates:

For students to gain the maximum benefit from this unit, the following procedures should be followed carefully. It is important that the students are allowed to interact in groups with the materials. The role of the tutor is that of manager rather than teacher. Do not become involved with groups unless they are completely confused.

(1)
- Divide students in groups of 3.
- Give each student a copy of entitled "which Dam?
- Give each group an answer sheet1.
- Allow 10-15 minutes for answering the questions.

(2)
- Form groups of six by putting two groups together.
- Give each group an answer sheet 2.
- Ask the groups of six to exchange their answers and come to an agreed set of answers, if this is possible.
- Allow 6-7 minutes.

(3)
- Bring everyone together.
- Ask each group of six to report back to you their decision about preferred location , with a reason.

Possible answer:

Actually all three positions are almost similar but each position has advantages and disadvantages. Depending on that, students can choose which advantage is the most important as soon as they could show evidence why they choose that position.

Is this really science?
PART ONE

If we really focus on some scientific issues, we may notice that these issues are sometimes puzzling. Often, those who write on these issues do not offer a precise answer. Furthermore, in some cases they give more than one answer.

One recent issue is the relationship between the use of mobile phones and brain cancer. From time to time we read new research about these phones. Unfortunately, all this research does not show clearly whether the use of mobile phones can cause brain cancer.

One of these studies is that of Dr. Lai at the University of Washington. He conducted an experiment where he put 100 rats in a tank of a water and taught them to swim around barriers to a submerged platform in the middle of the tank. The water contained powdered milk, so that the rats could not see where they were going but after a few trials the rats learned how to locate the platform. He then exposed half the rats to microwave radiation, and returned them all to the tank. The exposed rats forgot the way and swam randomly, while the others were able to find their way back. Lai interpreted this as the loss of spatial memory in the exposed subjects.

On the basis of Lai's experiments, people have argued that radiation from mobile phones can affect humans. Lai used radiation at frequency of 2.45 GHz while mobile use 0.9 or 1.8 GHz and he exposed the rats to one hour of this radiation at a power of 1.2 Watt per kilogram. A standard handset uses 0.25 W of which only a small fraction will be directed towards the user's body.

Working as a group

1. Discuss the significance of Lai's experiment
2. Is there enough evidence to draw any conclusions about the safety of mobile phones?
3. What more would you like to know to be able to draw conclusions with certainty?

Recorded your agreed answers as a group.

Is this really science?
PART TWO

Looking at the experiments carried out by Dr Lai's and the other data provided, it is clear that it is difficult to draw conclusions with certainty although the balance of probability as that mobile phones and mobile masts may pose further problems but, even here, it is unlikely that there are serious dangers.

Indeed, people have used Lai's experiments to try to show that mobile phones and phone masts are dangerous while others have suggested that his results do not show anything about the safety of mobile phones and phone masts. He is a reputable scientist and no doubt his experiments were conducted carefully and could be repeated with the same outcomes. The problem is how to interpret the results.

Some argue that, when science tell us something, it must be true. After all, experiments can be repeated and the results of the properly conducted experiments will always be more or less the same. Others argue that we cannot trust knowledge gained in this way. The have been too many examples of wrong conclusions being drawn from experiments.

As a group discuss the following:

1. What part of scientific knowledge is trustworthy?
2. What part of scientific knowledge can be criticized?
3. To what extent are we justified in the challenging scientific knowledge?
4. Is there a place for being critical and open-minded in science?

Is this really science?
Tutor's Guide

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- Assessment in science education.

To achieve these aims, students are given the opportunity to work in small groups to explore the nature of scientific knowledge. Through these units students are encouraged to use analysis, synthesis and evaluation of cognitive skills to achieve the aims.

At the end of this unit the student is expected to:

- Realise that knowledge derived from science is not always correct.
- Realise that knowledge derived from science is open to modification following further experimentation
- Appreciate that the knowledge derived from science must be weighed carefully before decisions are taken.
- Realise that knowledge derived from science is constructed and is open to development.

How the Unit Operates:

For students to gain the maximum benefit from this unit, the following procedures should be followed carefully. It is important that the students are allowed to interact in groups with the materials. The role of the tutor is that of manager rather than teacher. Do not become involved with groups unless they are completely confused.

(1)
- Divide students into groups of 3.
- Distribute part one to all students.
- Allow 10 minutes for reading, discussion and decision taking.
- Ask each group where possible to give you their answer.

(2)
- Give them part two of the teaching unit.
- Allow 10 minutes for reading, discussion and decision taking.
- Ask them to give you their answer on groups.

Debriefing:

It is useful to gather all the groups together at the end and to discuss issues raised by the unit. You may want to discuss issues like: what is scientific knowledge?.

Possible answers:

Part one:
1. Lai's experiment has nothing to do with brain cancer but it deals with loss of spatial memory. However, the experiment itself was well conducting.

2. No, because the circumstances are different from those which apply to mobile phones and human. For example the frequency and power Lai's used were higher than those in mobile phones.

3.
a. If the biological structure of rats and humans are same.
b. How will be rats behave if we use the same frequency and power in the mobile phone.

Part two:
1. Results obtained from experiments.
2. Interpretations made from the experiment results.
3. It is justified in some scientific knowledge.
4. Yes, because the scientists could make mistakes when they come to interpret their findings.

Assessment scheme Unit

A new course is to be introduced in secondary schools. This course will be about environmental education. One unit in this course is dealing with social and economical aspects related to the efforts to deal with some environmental problems. The main aim for this unit is to make students more aware that these aspects should be considered when we deal with any environmental problem.

For example, if a government wishes to pass legislation to stop the use of all substances affecting the ozone layer in industry, several aspects have to be considered:

- Companies profit may drop because the substance, which does not effect ozone layer, is more expensive. Furthermore, if we apply that suddenly, some companies may collapse.
- It may affect people's lives because the new products will be more expensive.
- If the sales for these companies come down, many workers in these companies may lose their jobs.

Any decision must consider factors like these. There is balance between reducing the production of materials which affected the ozone layer and a disruption of comments life. Change needs to be gradual.

In order to deal with this unit effectively, students need to have the ability to:

- Evaluate information and take decisions on the best evidence.
- Present an argument to an audience with carefully presented evidence.
- Summarize evidence obtained through books, handouts, web sites etc.

Your Task

You will work as a group of three.
Your task is to devise an assessment scheme for this unit.
Any assessment scheme must reflect the main aims of the unit and be practicable.

Here are some issues to consider:

Is objective testing appropriate?
How long will the assessment take?
Is all the assessment to be based on written tests?
Can we use several forms of assessment?

Answer sheet

Proposed your assessment scheme here:

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Tutor Guide
Assessment scheme Unit

Introduction:

This teaching unit is one of a set of teaching units devised for developing student teachers' perceptions of learning in the education colleges in the Sultanate of Oman. Beside developing mainly their perceptions of scientific knowledge they try to develop their perceptions of:

- Teacher role in science education.
- Students role science education.
- Assessment in science education.

To achieve these aims, students are given the opportunity to work in small groups to explore the nature of scientific knowledge. Through these units students are encouraged to use analysis, synthesis and evaluation of cognitive skills to achieve the aims.

At the end of this unit the student is expected to:

- Accept that there are many factors affecting some scientific decisions.
- Realize that in many cases to have effective assessment, the use of written tests may not be appropriate.
- Accept that students should be given the opportunity to show their own ideas in their assessment.

How the Unit Operates:

For students to gain the maximum benefit from this unit, the following procedures should be followed carefully. It is important that the students are allowed to interact in groups with the materials. The role of the tutor is that of manager rather than teacher. Do not become involved with groups unless they are completely confused.

(1)

Divide students into groups of three.
Distribute unit to all students.
Give them 3-5 minutes reading time.
Ask them to answer the question as a group (give them an answer sheet).

(2)

Ask each two groups to form one group.
Ask each new group to discuss their idea together and make one answer (give them a new answer sheet).
Ask each group if possible to give you their suggestion.

Possible answer:

The general features of the assessment are:

- Should give the students opportunity to express their own ideas.
- It is better to put students in real life situation.
- Multiple choice may not be a good way to assess this unit.

Students may have a variety of views about assessment of the unit. All may be worth discussed as soon as they assess the main aim of the unit.

Teaching units (Arabic)

من هو الشخص الأنسب لهذه الوظيفه؟

تقدم خمسة أشخاص لشغل وظيفة حارس في أحد المؤسسات جميعهم لديهم نفس الخبره والمؤهلات، وبقي التنافس فيما بينهم لتحديد الشخص الأنسب لهذه الوظيفة هو في دليل كتلة الجسم (BMI)، ذلك أن الدليل المذكور يعطي مؤشر جيد لمدى لياقة الشخص الأمر المهم بالنسبه للوظيفه المذكوره.

من أجل ذلك فقد تم تشكيل لجنه علميه لاختيار الشخص الأنسب لشغل تلك الوظيفة بناء على دليل كتلة الجسم، وعلى اللجنة أن تختار شخصا واحدا فقط.

ما هو دليل كتلة الجسم؟

دليل كتلة الجسم هو أحد أدق الطرق لتحديد أن الزيادة في وزن الجسم مقارنة بطوله قد تؤدي إلى مشاكل صحيه، وهو مقياس يأخذ في اعتباره وزن وطول الشخص لتحديد البدانه في البالغين بين سن 19 إلى 65 سنه. بمعنى أخر فهو يحاول أن يحدد ما إذا كان طول الشخص يتناسب مع وزنه.

كيف يحسب *دليل كتلة الجسم؟*

$$\text{دليل كتلة الجسم (BMI)} = \frac{\text{وزن الجسم}}{\text{طول الجسم}^{2}}$$

حيث يحسب وزن الجسم **بالكيلوغرام** ويحسب الطول **بالمتر**

بناء على هذا الدليل فانه عندما يكون دليل كتلة BMI للشخص ما بين 19 إلى 24.9 فأننا يمكن أن نعتبر ذلك وزن صحيا مقارنتا بطوله، أما إذا كان دليل كتلة الجسم يتراوح بين 25 إلى 29.9 فإننا نعتبر ذلك الشخص زائد الوزن،الشخص ذو BMI بين 30 إلى 39.9 فيعتبر بدين (سمين) أما إذا كان BMI 40 فأكثر فإن الشخص يعتبر بدين جدا أما إذا كان BMI أقل من 19 فانه يصنف بان عنده سوء تغذيه.

المطلوب منكم كمجموعة

ناقشوا من خلال مجموعتكم من هو أنسب شخص لشغل الوظيفة وذلك للوصول إلى إجابة متفق عليها؟

الاسم	أحمد	سعيد	علي	عيسى	راشد
الطول	1.71 متر	1.85 متر	1.72 متر	1.93 متر	1.78 متر
الوزن	68 كغم	73 كغم	75 كغم	80 كغم	74 كغم
العمر	23	18	25	26	22

من خلال مجموعتك قم بالآتي:

- أحسب BMI لكل شخص.
- هل يوجد من بين المتقدمين من لا يصلح لهذه الوظيفة؟
- من الشخص الذي قد اخترتم؟ ولماذا؟
- ناقش مع مجموعتك ما هي المعلومات الإضافيه التي قد تساعدكم في اتخاذ قراركم.

قد يطلب منكم إعطاء إجابتكم حول النقاش الذي دار في مجموعتكم

من هو الشخص الأنسب لهذه الوظيفة؟

دليل عضو هيئة التدريس

مقدمة:

هذه الوحده هي جزء من مجموعة وحدات تدريسيه الهدف منها جميعا تطوير وجهات نظر الطلاب المعلمين (تخصص علوم) لبعض قضايا التعلم في كليات التربية بسلطنة عمان، بالإضافه لتركيز هذه الوحدات على تطوير وجهات نظر الطلاب المعلمين حول المعرفة العلميه فإنها تحاول تطوير وجهات نظر الطلاب حول القضايا الآتيه:

- دور معلم العلوم في التربية العلميه.
- دور الطالب في التربية العلميه.
- التقويم في التربية العلميه.

لتحقيق أهداف هذه الوحدات سوف تتاح الفرصه للطلاب المعلمين للعمل من خلال مجموعات صغيره لاكتشاف طبيعة المعرفة العلميه، كما سيتم تشجيع الطلاب على استخدام المهارات المعرفية الآتيه: التحليل والتركيب والتقويم للوصول لأهداف هذه الوحدات.

بعد انتهاء الطالب من هذه الوحده يتوقع منه أن:

- يحسب دليل كتلة الجسم.
- يستنتج من خلال دليل كتلة الجسم لشخص ما مدى لياقته.
- يقدر أن الأدلة العلمية قد لا تؤدي دائما إلى إجابة محدده إما ابيض أو أسود.

كيف تدار الوحده:

لتحقيق أقصى عائد من هذه الوحدات يرجى اتباع الإجراءات التاليه بدقه ومن الضروري إتاحة الفرصه للطلاب للتفاعل مع الوحدات في مجموعات صغيره.

(1)
قسم الطلاب إلى مجموعات صغيره تتكون من ثلاثة طلاب ووزع الوحده على جميع الطلاب وأعطي من 10 إلى 12 دقيقه لكل المجموعات حتى تقرأ الوحده وتجاوب على أسئلتها.

أخي/ أختي عضو عضوه هيئة التدريس تذكر:

- ☐ **دور عضو هيئة التدريس في هذه الوحدات هو كمدير أكثر من كونه مدرس.**
- ☐ **لا تحاول التدخل في النقاش الدائر في المجموعات إلا إذا لاحظت وجود سوء فهم من قبل الطلاب.**

الإجابات الممكنه:

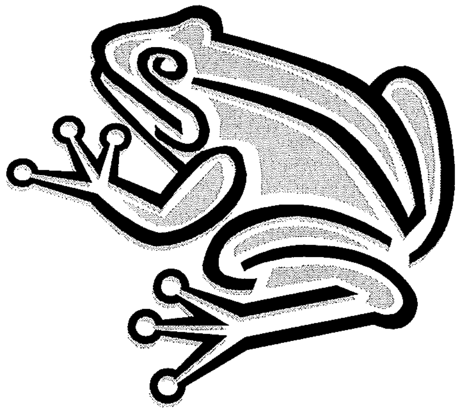
الاسم	أحمد	سعيد	علي	عيسى	راشد
BMI	23.2	21.3	25.3	21.4	23.3

من خلال الجدول الموجود في الوحده والجدول السابق يتضح جليا ما يأتي:

- يمكن اعتبار علي شخص غير مناسب لشغل الوظيفه حيث أنه بناء على BMI الخاص به يمكن اعتباره شخص زائد الوزن.
- سعيد أيضا شخص غير مناسب لشغل الوظيفه ذلك أن عمره أقل من 19 سنه وبالتالي لا يمكن أن نطبق عليه مقياس BMI.

من الصعب في ضوء قيم BMI للأشخاص الثلاثه الآخرين أن نقرر ببساطه استحقاق أي منهم للوظيفة. لذلك أي قرار يتخذ يجب أن يأخذ في اعتباره عوامل أخرى ولكن لم تعطى أي عوامل أخرى. وعلى أي حال فان العلم قد يسلك نفس المسلك أحيانا حيث أن الأدلة العلمية قد لا تتيح لنا أن نستنتج إجابة قاطعه منها.

الضفدع الخاص
الجزء الأول



من خلال مجموعتك حاول الإجابة على الأسئلة التالية

لبعض أنواع الضفادع غشاء رقيق من الجلد بين أصابعها.

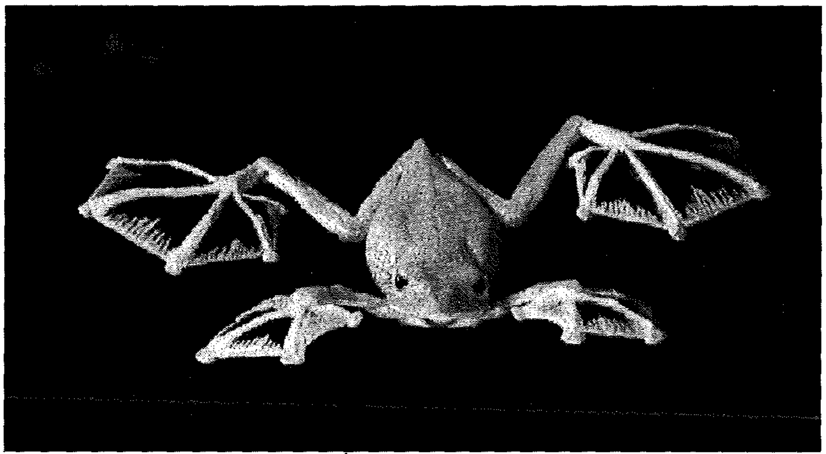
ناقش الوظيفه المحتمله لهذا الغشاء الرقيق الموجود بين أصابع هذه الضفادع؟

ما هي الإجابة التي اتفقت عليها المجموعة؟

ليقوم شخص في المجموعة بكتابة الإجابة المتفق عليها

الضفدع الخاص
الجزء الثاني

هذه بعض المعلومات الإضافية عن هذه الضفادع



صوره (1): ضفدع الأشجار

هذا النوع من الضفادع تدعى ضفادع الأشجار، ذلك أنها تقضي معظم وقتها في الأشجار مع أنها تسبح وتضع بيضها في الماء، يوجد هذا النوع من الضفادع في بروناي وسومطره وجنوب جزيرة الفليبين بالإضافة لدول أخرى من العالم.

في ضوء المعلومات الإضافية عن هذه الضفادع ماذا تتوقع أن تكون الوظيفة المحتمله لهذا الغشاء بين أصابع هذه الضفادع؟

ناقش مع مجموعتك الوظيفة المحتمله وليقوم شخص في المجموعة بكتابة الإجابة

<u>الضفدع الخاص</u>
<u>*الجزء الثالث*</u>

هذه معلومات إضافية أخرى عن هذه الضفادع

تستطيع هذا الضفادع أن تقفز من شجره إلى أخرى لمسافات بعيده. بالإضافه إلى ذلك فإنها تستطيع أن تستدير في الجو بزاوية مقدارها 180 درجه.

في ضوء المعلومات الإضافية ماذا تعتقد أن تكون وظيفة هذا الغشاء؟
ناقش السؤال مع مجموعتك وليقوم شخص في المجموعة بكتابة الإجابة

الضفدع الخاص

دليل عضو هيئة التدريس

مقدمة:

هذه الوحده هي جزء من مجموعة وحدات تدريسيه الهدف منها جميعا تطوير وجهات نظر الطلاب المعلمين (تخصص علوم) لبعض قضايا التعلم في كليات التربية بسلطنة عمان، بالإضافه لتركيز هذه الوحدات على تطوير وجهات نظر الطلاب المعلمين حول المعرفه العلميه فإنها تحاول تطوير وجهات نظر الطلاب حول القضايا الآتية:

- دور معلم العلوم في التربية العلميه.
- دور الطالب في التربية العلميه.
- التقويم في التربية العلميه.

لتحقيق أهداف هذه الوحدات سوف تتاح الفرصه للطلاب المعلمين للعمل من خلال مجموعات صغيره لاكتشاف طبيعة المعرفه العلميه، كما سيتم تشجيع الطلاب على استخدام المهارات المعرفية الآتية: التحليل والتركيب والتقويم للوصول لأهداف هذه الوحدات.

بعد انتهاء الطالب من هذه الوحده يتوقع منه أن:

- تتكون لديه فكره بسيطه عن ضفادع الأشجار أو الضفادع الطائرة.
- يدرك أن المعرفه المستقاه من العلم قد تتغير إذا توفرت لدينا معلومات جديده.

كيف تدار الوحده:

لتحقيق أقصى عائد من هذه الوحدات يرجى اتباع الإجراءات التاليه بدقه، ومن الضروري إتاحة الفرصه للطلاب للتفاعل مع الوحدات في مجموعات صغيره.

(1)

- قسم الطلاب إلى مجموعات صغيره تتكون من 3 طلاب.
- وزع الجزء الأول من الوحده إلى جميع الطلاب مع إعطائهم دقيقتين لقرأتها.
- اطلب من كل مجموعه من الطلاب أن يختارون شخص واحد ليكتب الإجابة التي توصلت إليها مجموعته.
- اطلب من كل مجموعة أن تعطيك إجابتهم واكتب جميع الإجابات على السبورة (**الإجابة المتوقعه هنا أن وظيفة الغشاء الموجود بين أصابع هذه الضفادع هو للسباحة).**

(2)

- وزع الجزء الثاني من الوحده إلى جميع الطلاب مع إعطائهم دقيقتين لقرأتها.
- اطلب منهم الإجابة على السؤال كمجموعه.
- اطلب من كل مجموعه أن تعطيك الإجابة المتفق عليها وقم بتسجيل الإجابة الجديدة لكل مجموعه بجانب إجابتها السابقة **(الإجابة المتوقعه هنا للقفز أو من الممكن أن تكون إجابة بعض المجموعات للسباحه).**

(3)

- وزع الجزء الثالث من الوحده على جميع الطلاب مع إعطائهم دقيقتين لقرأتها.
- اطلب من كل مجموعه بعد أن تصل إلى إجابة موحده أن يعطوك الإجابة وقم بكتابتها بجوار الإجابتين السابقتين لنفس المجموعة (**الإجابة المتوقعه هي للقفز).**
- قارن بين الإجابات المختلفه لكل مجموعه واطلب من الطلاب أن يفسروا سبب اختلاف إجابتهم بين كل جزء وأخر إذا وجد أي تغير.

أخي/ أختي عضو/ عضوه هيئة التدريس تذكر:

- ☐ **دور عضو هيئة التدريس في هذه الوحدات هو كمدير أكثر من كونه مدرس.**
- ☐ **لا تحاول التدخل في النقاش الدائر في المجموعات إلا إذا لاحظت وجود سوء فهم من قبل الطلاب.**

الإجابات الممكنه:

الإجابات الممكنه محتواه في الجزء الخاص بكيفية إدارة الوحده.

خلاصه:

حاول أن تناقش مع الطلاب سبب تغير إجاباتهم مع توضيح أن المعرفه العلميه ما هي إلا أفضل فهم متوفر لدينا عن ظاهره معينه بناء على المعلومات المتوفرة لدينا، ويمكن أن تتغير إذا توفرت لدينا معلومات جديده، بمعنى أخر أن المعرفه العلميه قد تتغير إذا اكتشفنا أدله علميه جديده تدعم التغير.

أي سد أفضل؟

من المعروف أن مشكلة نقص المياه العذبه من المشاكل البيئيه المهمه في سلطنة عمان، وللعمل على تقليل الآثار السلبيه المترتبه على هذه المشكله قامت الحكومه ببناء السدود في مختلف مناطق السلطنه، في هذه السنه قررت الحكومة إنشاء سد جديد في منطقة الباطنة، العمر الافتراضي له قبل أي اصلاحات رئيسيه 50 عام، هذا السد كما بينت الدراسات يمكن أن ينشأ في ثلاثة مواقع لكل موقع من هذا المواقع إيجابيات وسلبيات.

بالنظر في الجدول التالي حاول أن تناقش مع مجموعتك إيجابيات وسلبيات كل سد وذلك لاختيار أنسب موقع لبناء السد

	الموقع 1	**الموقع 2**	**الموقع 3**
التكلفة	2 مليون ريال	1.2 مليون ريال	1.85 مليون ريال
القدره التخزينيه	3 كم٣	2.3 كم٣	2.6 كم٣
تكلفة الصيانه في كل سنه	20000 ريال	21500 ريال	20000 ريال
المساحه التي سوف تغمرها مياه السد	15 كم٢	20 كم٢	14.5 كم٢

من الممكن أن يقوم شخص واحد من المجموعة بكتابة الإجابات المتفق عليها في ورقة الإجابة رقم **1**

<u>ورقة الاجابه 1</u>

1- حسب رأي المجموعة ما هو الموقع الأنسب لإنشاء السد؟

....

....

2- ما هي أسباب اختياركم للموقع؟

....

....

....

....

....

3- هل انتم واثقين من أن إجابتكم هي الإجابة الوحيدة الصحيحة؟

....

....

4- لماذا؟

....

....

....

....

ورقة الاجابه 2

1- حسب رأي المجموعة ما هو الموقع الأنسب لإنشاء السد؟

....

....

2- ما هي أسباب اختياركم للموقع؟

....

....

....

....

....

3- هل انتم واثقين من أن إجابتكم هي الإجابة الوحيدة الصحيحة؟

....

....

4- لماذا؟

....

....

....

....

أي سد أفضل؟
دليل عضو هيئة التدريس

مقدمة:

هذه الوحده هي جزء من مجموعة وحدات تدريسيه الهدف منها جميعا تطوير وجهات نظر الطلاب المعلمين (تخصص علوم) لبعض قضايا التعلم في كليات التربية بسلطنة عمان، بالإضافه لتركيز هذه الوحدات على تطوير وجهات نظر الطلاب المعلمين حول المعرفة العلميه فانها تحاول تطوير وجهات نظر الطلاب حول القضايا الآتية:

- دور معلم العلوم في التربية العلميه.
- دور الطالب في التربية العلميه.
- التقويم في التربية العلميه.

لتحقيق أهداف هذه الوحدات سوف تتاح الفرصه للطلاب المعلمين للعمل من خلال مجموعات صغيره لاكتشاف طبيعة المعرفة العلميه، كما سيتم تشجيع الطلاب على استخدام المهارات المعرفيه الآتيه التحليل والتركيب والتقويم للوصول لأهداف هذه الوحدات.

بعد انتهاء الطالب من هذه الوحده يتوقع منه أن:

- يدرك أنه في الكثير من المواقف العلميه لا توجد إجابة صحيحه واحده فقط.
- يقدر أهمية أن نضع في اعتبارنا الكثير من العوامل عند اتخاذ الكثير من القرارات العلميه.

كيف تدار الوحده:

لتحقيق أقصى عائد من هذه الوحدات يرجى اتباع الإجراءات التاليه بدقه ومن الضروري إتاحة الفرصه للطلاب للتفاعل مع الوحدات في مجموعات صغيره.

أخي/ أختي عضو عضوه هيئة التدريس تذكر:

- ☐ **دور عضو هيئة التدريس في هذه الوحدات هو كمدير أكثر من كونه مدرس.**
- ☐ **لا تحاول التدخل في النقاش الدائر في المجموعات إلا إذا لاحظت وجود سوء فهم من قبل الطلاب.**

(1)

- قسم الطلاب إلى مجموعات مكونه من 3.
- أعط كل طالب نسخه من الوحدة.
- أعط كل مجموعة ورقة اجابه رقم 1.
- أعط المجموعات 10 إلى 15 دقيقه للاجابه على الأسئلة.

(2)

- كون مجموعات مكونه من ستة طلاب وذلك بجمع كل مجموعتين مع بعض.
- أعط لكل مجموعه ورقة الإجابة رقم 2.
- اطلب من كل مجموعه مكونه من ستة طلاب أن يتناقشون في إجاباتهم وان يحاولون الوصول إلى اجابه موحده ما أمكن.
- أعط 6 إلى 7 دقائق لذلك.

(3)

- اطلب من جميع المجموعات أن يوقفوا النقاش وان ينتبهوا معك.
- اطلب من كل مجموعه مكونه من 6 طلاب أن يخبروك بقرارهم مع توضيح الأسباب.

الإجابة الممكنة للوحده:

في الواقع تتقارب المواقع الثلاثة في الإيجابيات والسلبيات لكل منها. بناء على ذلك يمكن للطالب أن يحدد ما هو العامل الأهم بالنسبه له ما دام يستطيع أن يدعم قراره بالأدلة العلمية.

هل هكذا بالفعل العلم
الجزء الأول

لو ركزنا على بعض القضايا العلميه للاحظنا أنها محيره جدا لدرجة أن بعض اللذين يكتبون عن هذه القضايا لا يقومون بإعطاء أجوبه محدده للكثير من الأسئلة التي تدور حول هذه القضايا وفي الكثير من الأحيان يعطون أكثر من احتمال أو إجابة.

أحد أبرز هذه القضايا هي العلاقه بين استخدام الهاتف النقال وسرطان الدماغ، فبين فتره وأخرى نقرأ دراسة جديد عن هذه الهواتف، ولسوء الحظ جميع هذه الدراسات لا تبين للقراء بوضوح ما إذا كانت هذه الهواتف تسبب بالفعل سرطان الدماغ.

واحده من هذه الدراسات هي الدراسه التي قام بها الدكتور لي في جامعة واشنطن في الولايات المتحدة، حيث قام بإجراء تجربه وضع فيها 100 فأر في حوض وعلمهم السباحه في حوض من الماء حتى يصلوا إلى قاعدة مغموره تحت الماء في وسط الحوض ويقفون عليها، طبعا الماء مضاف إليه مسحوق حليب ابيض حتى لا تشاهد الفئران القاعدة التي تحت الماء ولكن يجب عليها أن تحفظ المكان، بعد عدة محاولات أصبحت الفئران تحدد مكان القاعدة بسهوله، بعد ذلك قام د. لي بتعريض نصف الفئران إلى أمواج المايكرويف (نفس الأمواج المستخدمه في الهواتف النقاله)، ثم أعاد جميع الفئران إلى الحوض، لاحظ د. لي أن الفئران التي تعرضت للأمواج أخذت تسبح بعشوائيه ولم تستطع التعرف على مكان القاعدة أما الفئران التي لم تتعرض للأمواج استطاعت أن تعرف طريقها إلى القاعدة بسهوله، ولقد فسر ذلك بفقدان الفئران التي تعرضت للأمواج للذاكره المكانيه حيث فقدت تذكرها للأماكن.

بناء على نتائج تجربة د. لي أخذ الناس يناقشون أنه من الممكن للأمواج المنبعثه من الهواتف النقاله أن تؤثر على البشر، بينما نجد أن د. لي استخدم في تجربته أمواج ذات تردد 2.45 ميجاهيرتز بينما الامواج المستخدمه في الهواتف النقاله تتراوح بين 0.9 الى 1.8 ميجاهيرتز ولقد عرض هذه الفئران لساعه متصله من هذه الامواج بقوه مقدارها 1.2 واط لكل كليوغرام بينما كل جهاز خلوي يستخدم قوه مقدارها 0.25 واط الامر الذي يجعل جزء بسيط من هذا يتجه إلى جسم المستخدم.

من خلال مجموعتك:

ناقش دلالة تجربة د. لي بالنسبه لسرطان الدماغ؟
هل توجد ادله كافيه للوصول الى الاستنتاج عن سلامة استخدام الهواتف النقاله؟
ما الأشياء التي تود معرفتها لتصبح قادرا على أن تصل إلى استنتاج قاطع حول سلامة استخدام الهواتف النقاله؟

هل هكذا بالفعل العلم
الجزء الثاني

بالنظر إلى تجربة د. لي والمعلومات الأخرى التي في الجزء الأول يتجلى بوضوح انه من الصعب الوصول إلى استنتاج أكيد بالرغم من وجود احتمال معقول أن الهواتف النقاله ومحطاتها قد تسبب بعض المشاكل ولكن هذا الموضع يبدو أن الضرر المترتب ليس خطرا جدا.

في الحقيقه لقد استخدم الكثير من الناس تجربة د. لي ليثبتوا أن الهواتف النقاله ومحطاتها خطيره بينما يرى آخرون أن النتائج لا تثبت أي شي حول سلامة استخدام الهواتف النقاله ومحطاتها مع اعترافهم بأن د. لي عالم معروف وان تجربته سليمه ويمكن إعادتها والحصول على نفس النتائج لكن المشكله تكمن في تفسير النتائج التي حصل عليها د. لي.

البعض يصر على أنه عندما يخبرنا العلم بشيْ فأنه بالضرورة أن يكون صحيحا، ذلك أنه حسب تفسيرهم باننا يمكن أن نعيد التجربه التي حصلنا بواسطتها على المعرفه العلميه وتعطينا نفس النتيجة بينما يرى آخرون باننا لا يمكن أن نكون على يقين قاطع 100 % أن المعلومات العلميه التي وصلنا اليها بهذه الطريقه صحيحه، ذلك أنه وإن كانت إجراءات التجربة صحيحه قد يكون الاستنتاج الذي بنيناه على نتائج التجربة خاطئ.

كمجموعة ناقشوا الأسئله الاتيه:

- **ما الجزء من المعرفه العلميه الذي يمكن أن يكون صحيحا بصوره قاطعه؟**
- **ما الجزء من المعرفه العلميه الذي يمكن أن يناقش؟**
- **إلى أي مدي يمكننا أن نسوغ نقد المعرفه العلميه؟**
- **هل يوجد مجال لنكون منتقدين في العلوم؟**

هل هكذا بالفعل العلم
دليل عضو هيئة التدريس

مقدمة:

هذه الوحده هي جزء من مجموعة وحدات تدريسيه الهدف منها جميعا تطوير وجهات نظر الطلاب المعلمين (تخصص علوم) لبعض قضايا التعلم في كليات التربيه بسلطنة عمان، بالاضافه لتركيز هذه الوحدات على تطوير وجهات نظر الطلاب المعلمين حول المعرفه العلميه فإنها تحاول تطوير وجهات نظر الطلاب حول القضايا الآتية:

- دور معلم العلوم في التربية العلميه.
- دور الطالب في التربية العلميه.
- التقويم في التربية العلميه.

لتحقيق أهداف هذه الوحدات سوف تتاح الفرصه للطلاب المعلمين للعمل من خلال مجموعات صغيره لاكتشاف طبيعة المعرفه العلميه، كما سيتم تشجيع الطلاب على استخدام المهارات المعرفيه الاتيه: التحليل والتركيب والتقويم للوصول لأهداف هذه الوحدات.

بعد انتهاء الطالب من هذه الوحده يتوقع منه أن:

- يدرك أن المعرفة التي تستقى من العلم ليست دائما صحيحه.
- يدرك أن المعرفة المستقاه من العلم قد تتغير إذا اكتشفنا معلومات جديده.
- يقدر أن المعرفة المستقاه من العلم يجب أن توزن جيدا قبل اتخاذ أي قرار اعتمادا عليها.
- يدرك أن المعرفة العلميه هي معرفه تراكميه وأنها قابله للتطور.

كيف تدار الوحده:

لتحقيق أقصى عائد من هذه الوحدات يرجى اتباع الإجراءات التاليه بدقه ومن الضروري إتاحة الفرصه للطلاب للتفاعل مع الوحدات في مجموعات صغيره.

(1)
- وزع الطلاب إلى مجموعات صغيره مكونه من 3 طلاب.
- وزع الجزء الأول من الوحده على جميع الطلاب.
- أعط 10 دقائق للطلاب لقراءة ومناقشة الوحده والإجابة على أسئلتها.
- اطلب من كل مجموعه إن أمكن أن تعطيك إجاباتها.

(2)
- أعط جميع الطلاب الجزء الثاني من الوحده.
- أعطهم 10 دقائق لقراءة ومناقشة الوحده ثم الوصول إلى إجابات لأسئلتها.
- اطلب منهم أن يعطوك إجاباتهم من خلال مجموعات.

أخي/ أختي عضو عضوه هيئة التدريس تذكر:

- ☐ **دور عضو هيئة التدريس في هذه الوحدات هو كمدير أكثر من كونه مدرس.**
- ☐ **لا تحاول التدخل في النقاش الدائر في المجموعات إلا إذا لاحظت وجود سوء فهم من قبل الطلاب.**

الإجابات الممكنه:

الجزء الأول:

1. تجربة د. لي لم تتعرض للعلاقة بين سرطان الدماغ واستخدام الهواتف النقاله ولكنها بين استخدام الهواتف النقاله وفقدان الذاكرة المكانية مع أن التجربة في حد ذاتها كانت مجراه بصوره جيده.

2. لا، لان الظروف التي أقيمت فيها التجربة تختلف عن التي في الهواتف النقاله وفي الإنسان، فعلى سبيل المثال التردد وقوه الأمواج في تجربة د. لي اكثر بكثير من المستخدمة في الهواتف النقاله.

3. أ. هل تركيبة الإنسان البيولوجية نفس تركيبة الفئران؟
ب. كيف يمكن أن تتصرف الفئران لو طبقنا عليها نفس التردد والقوه التي تستخدم في الهواتف النقاله؟

الجزء الثاني:

1. النتائج التي نحصل عليها من التجارب.

2. التفسير الذي نبنيه على نتائج التجارب.

3. مسوغ في أجزاء من المعرفة العلميه.

4. نعم ذلك أن العلماء قد يرتكبوا أخطاء عند قيامهم بتفسير بعض ما توصلوا إليه.

خلاصه:

من المفيد جمع جميع الطلاب مع بعض بعد الانتهاء من الوحده لمناقشة بعض القضايا التي أثيرت من خلال الوحده مثل ما هي المعرفة العلميه؟

مخطط تقويم وحدة دراسيه

قررت وزارة التربية والتعليم طرح مقرر جديد في المرحلة الثانويه عن التربية البيئية، أحد الوحدات المكونه لهذا المقرر تتكلم عن الاعتبارات الاجتماعيه والاقتصادية المتعلقه بالجهود المبذوله للتعامل مع المشكلات البيئيه، الهدف الرئيسي لهذه الوحداه هو زيادة وعي الطلاب بضرورة اعتبار هذه الجوانب (الاجتماعيه والاقتصاديه) عند التعامل مع أية مشكله بيئيه.

على سبيل المثال إذا رغبت الحكومه في وضع تشريع جديد لمنع استخدام المواد المؤثره على طبقة الأوزون في الصناعه فانه ينبغي أن تراعي عدة نقاط منها:

- قد تنخفض الفائده التي تحققها الشركات التي تتعامل بهذه المواد، ذلك أن سعر المواد البديله التي لا تؤثر على طبقة الأوزون أغلى، أضف إلى ذلك أنه إذا طبقنا القانون بصوره مفاجئه قد تنهار بعض الشركات.
- قد تؤثر على حياة المواطنين نتيجة كون المنتج الجديد أغلى سعرا.
- إذا انخفضت مبيعات الشركات فان ذلك قد يؤدي إلى خسارة بعض الموظفين في هذه الشركات لوظائفهم.

بناء على ذلك فإن أي قرار يتخذ يجب أن يضع في اعتباره مثل هذه النقاط، ولعل الموازنه بين تخفيض إطلاق هذه المواد المؤثره على طبقة الأوزون والتأثير على حياة الناس مطلب ضروري وملح لذلك يجب أن يكون التغير تدريجي.

لكـــي يقـــوم الطـــلاب بالـــتفاعل مـــع هـــذه الوحـــده بفاعلـــيه ينبغـــي أن تكـــون لديهـــم القـــدره علـــى أن:

- يقيموا المعلومات المتوفره لديهم لاتخاذ قراراتهم بناء على أفضل الأدله العلميه المتوفره لديهم.
- يقدموا نقاشهم المتعلق بكيفية التعامل مع هذه القضايا للجمهور مدعمه بالأدله العلميه.
- تلخيص الأدله العلميه التي يستخرجوها من الكتب والإنترنت .... الخ.

ما المطلوب منكم كمجموعة؟

- *ستقوموا بالعمل من خلال مجموعات مكونه من ثلاثة أشخاص.*
- المطلوب منكم وضع مخطط لكيفية تقويم هذه الوحده.
- تذكروا أن أي مخطط يوضع يجب أن يراعي الأهداف الرئيسيه للوحده وأن يكون قابل للتطبيق.

القضايا التي ممكن أن تراعى:

- **هل الأسئلة الموضوعية مناسبة لتقيم هذه الوحده؟**
- **كم من الوقت سيستغرق التقويم؟**
- **هل سيكون التقويم كتابيا؟**
- **هل من الممكن استخدام اكثر من أسلوب للتقويم؟**

مخطط تقويم وحدة دراسيه

ورقة اللاجابه 1

ضع مخطط التقويم هنا

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مخطط تقويم وحدة دراسيه

ورقة اللاإجابه 2

ضع مخطط التقويم هنا

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مخطط تقويم وحدة دراسيه
دليل عضو هيئة التدريس

مقدمة:

هذه الوحده هي جزء من مجموعة وحدات تدريسيه الهدف منها جميعا تطوير وجهات نظر الطلاب المعلمين (تخصص علوم) لبعض قضايا التعلم في كليات التربية بسلطنة عمان، بالإضافه لتركيز هذه الوحدات على تطوير وجهات نظر الطلاب المعلمين حول المعرفه العلميه فإنها تحاول تطوير وجهات نظر الطلاب حول القضايا الآتيه:

- دور معلم العلوم في التربية العلميه.
- دور الطالب في التربية العلميه.
- التقويم في التربية العلميه.

لتحقيق أهداف هذه الوحدات سوف تتاح الفرصه للطلاب المعلمين للعمل من خلال مجموعات صغيره لاكتشاف طبيعة المعرفه العلميه، كما سيتم تشجيع الطلاب على استخدام المهارات المعرفيه الآتيه: التحليل والتركيب والتقويم للوصول لأهداف هذه الوحدات.

بعد انتهاء الطالب من هذه الوحده توقع منه أن:

- يتقبل وجود أكثر من عامل يؤثر في اتخاذ الكثير من القرارات العلميه.
- يدرك أنه في كثير من الحالات للوصول لتقيم فعال قد لا تكون الامتحانات الكتابيه مجديه.
- يتقبل فكرة ضرورة إعطاء الطلاب الفرصه لإعطاء أفكارهم في التقويم.

كيف تدار الوحده:

لتحقيق أقصى عائد من هذه الوحدات يرجى اتباع الإجراءات التاليه بدقه ومن الضروري إتاحة الفرصه للطلاب للتفاعل مع الوحدات في مجموعات صغيره.

(1)
- وزع الطلاب إلى مجموعات صغيره مكونه من 3 طلاب.
- وزع الوحده على جميع الطلاب.
- أعط الطلاب من 3 إلى 5 دقائق لقراءة الوحده.
- اطلب منهم أن يجيبوا على السؤال كمجموعه (أعط كل مجموعه ورقة إجابة رقم 1).

(2)
- أطلب من كل مجموعتين أن يشكلون مجموعه واحده.
- أطلب من كل مجموعه أن تناقش المخطط مع بعض وذلك لعمل مخطط مشترك (أعط كل مجموعه ورقة أجابه رقم 2).
- أطلب من كل مجموعه إن أمكن أن يشرحوا مخططهم.

أخي/ أختي عضو عضوه هيئة التدريس تذكر:

- ☐ **دور عضو هيئة التدريس في هذه الوحدات هو كمدير أكثر من كونه مدرس.**
- ☐ **لا تحاول التدخل في النقاش الدائر في المجموعات إلا إذا لاحظت وجود سوء فهم من قبل الطلاب.**

الإجابات الممكنه:

الخصائص العامه لتقويم هذه الوحدة:

- يجب أن تتاح الفرصه للطلاب أن يعطوا أفكارهم.
- من الأفضل وضع الطلاب في مواقف حياتيه حقيقه والطلب منهم التعامل معها.
- قد تكون أسئلة الاختيار المتعدد ليست طريقه جيده لتقييم هذه الوحدة.

قد يكون عند الطلاب وجهات نظر متنوعه لتقييم هذه الوحده، وقد تكون جميعها قابله للنقاش والتطبيق ما دام أنها تقيم الأهداف العامه للوحده.

APPENDIX M

Students' interview

Interview with science education students

My name is Abdullah Al-Shibli a PhD student in centre for science education university of Glasgow UK. This interview is part of my research and it will treated confidentially and will just used for research purposes only.

1. What do you like most in these teaching units? (if any)

....

....

....

2. What do you dislike in these teaching units? (if any)

....

....

....

3. Do u think that it is useful to have units like these in schools? Why?

....

....

....

4. What do you think the units do for you?

....

....

....

Thank you for your time.

مقابله مع طلاب التربيه العلميه

السلام عليكم ورحمة الله وبركاته

اسمي عبدالله الشبلي طالب دكتوراه في جامعة جلاسكو بالمملكة المتحدة، المقابله التي سأجريها معك هي جزء من الدراسه التي أقوم بها والمعلومات التي سوف أحصل عليها ستعامل بسريه ولن تستخدم إلا لأغراض البحث العلمي.

س 1. ما أكثر شي أعجبك في هذه الوحدات التدريسيه؟ (إن وجد)

....

....

....

س 2. ما الذي لم يعجبك في هذه الوحدات؟ (إن وجد)

....

....

....

س 3. هل تعتقد أنه من المفيد وجود مثل هذه الوحدات في المدارس؟ ولماذا؟

....

....

....

س 4. ما الهدف الرئيسي من هذه الوحدات في اعتقادك؟

....

....

....

شكرا لحسن تعاونك

APPENDIX N

Centre for science education letter for experimental part

The Centre for Science Education

From: Dr Norman Reid
Director
Telephone: 0141-330-5172
Fax: 0141-330-3755
E-Mail: N.Reid@mis.gla.ac.uk

UNIVERSITY
of
GLASGOW

March 2002

The Director General
Colleges of Education
Sultanate of Oman

To Whom It May Concern

This letter confirms that Mr Abdullah Ali Said Alshibli is a matriculated postgraduate student studying for a PhD in the Centre for Science Education. This confirms that he wishes to conduct a research experiment with college students. He will contact you in due course to discuss the details of what he proposes to do

Dr Norman Reid
Director

CENTRE FOR SCIENCE EDUCATION
Kelvin Building, University of Glasgow, GLASGOW G12 8QQ
Director: Dr Norman Reid: 0141-330-5172
Emeritus Professor: Professor Alex. H. Johnstone
Direct Line: 0141-330-6565 Fax: 0141-330-3755
Web Site: http://www.gla.ac.uk/centres/scienceeducation

APPENDIX O

General Directorate of Education letter for experimental part

بسم الله الرحمن الرحيم

Sultanate of Oman
Ministry of Higher Education
Directorate General of
The Colleges of Education
Office of the Director General
No. : ....
Date : ....

سلطنة عمان
وزارة التعليم العالي
المديرية العامة لكليات التربية
مكتب المدير العام
الرقم : ك.ع.ك/٧/٢٨٤٦/ ٢٠٠٦م
التاريخ : ....
الموافق : ٥/٣/٢٠٠٦م

الأفاضل/ عمداء الكليات المحترمين

السلام عليكم ورحمة الله وبركاته ... وبعد

الموضوع/ تسهيل مهمة باحث

الرجاء التكرم بتسهيل مهمة الفاضل/ عبدالله بن علي بن سعيد الشبلي المدرس المساعد بكلية التربية بصحار لاستكمال متطلبات رسالة الدكتوراه في مجال طرق تدريس العلوم بجامعة جلاسكو بالمملكة المتحدة (بريطانيا) .

شاكرين لكم حسن تعاونكم .

وتفضلوا بقبول فائق الاحترام

د. محمد بن سليمان البندري
مدير عام كليات التربية

سلطنة عُمان، ص.ب: ٨٢ روي، الرمز البريدي ١١٢، هاتف: ٦٨٦٣٣٣، فاكس: ٦٨٥٣٧٨
Sultanate of Oman, P.O. Box 82, Ruwi, Postal Code 112, Tel. : 686333, Fax : 685378
E-mail: colleges@omantel.net.com

APPENDIX P

Experiment data

Post-questionnaire data for control group

colleg	sex	spe	year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
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Pre-questionnaire data for control group

college	sex	spe	year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
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Post-questionnaire data for experimental group

colleg	sex	spe	year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
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Pre-questionnaire data for experimental group

colle	sex	spe	year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
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